Engineering Library

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"THE ENGINEER," SEPTEMBER 30, 1927.

With METALLURGICAL SUPPLEMENT.

The Engineer.

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The Engineer

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Army Contracts.
TENDERS will be received by the Director of Army Contracts up to 11 a.m. 26th October, 1927, for the PURCHASE of the following :—
SIX AERIAL ROPEWAYS :—
Makers, Simplex Co., Coventry. Half-mile units, each complete with 4-cylinder, 14 H.P. water-cooled petrol engine and spares.
FOUR "WOMBAT" BORING MACHINES :—
Makers, Holman Bros., Ltd., Cornwall. Complete in cases with spare parts, together with a quantity of tubing. All are dismantled and packed in cases.
Further information and Tender forms can be obtained on application to the DIRECTOR OF ARMY CONTRACTS, Caxton House West, Tothill-street, London, S.W. 1. 6619

The Director-General,
India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, invites TENDERS for :—
1. 40 STEEL CRANK AXLES for LOCOMOTIVES.
2. 25 METRE-GAUGE BOGIE TIMBER TRUCKS.
Tenders due on the 18th October, 1927, for No. 1, and on the 8th November, 1927, for No. 2.
Specifications and forms of Tender obtainable from the above at a fee of 5s. per set, which will not be returned. 6617

Assistant District Engineer required by the GOVERNMENT of CEYLON for the RAILWAY DEPARTMENT for three years' service, with possible extension. Salary £450, rising to £600 a year by annual increments of £30. Free passages. Candidates, preferably unmarried, between the ages of 26 and 31, should be A.M.I.C.E. or possess equivalent professional qualifications and have had at least three years' suitable experience on Railway Construction or Maintenance. Must be capable of assisting a District Engineer in charge of a district of about 200 miles carrying on any or all the duties of District Engineer if and as required, and should be capable of designing bridges, buildings, and other structures including reinforced concrete work, and of making all calculations necessary for these works.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/151. 6616

Civil Engineer Required by the GOVERNMENT of SIERRA LEONE for the PUBLIC WORKS DEPARTMENT for two tours of from 12 to 18 months' service with possible extension. Salary £600, rising by annual increments to £720 a year. Outfit allowance of £60 on first appointment. Free passages and quarters and liberal leave on full salary. Candidates, aged 30 to 35, must have served articles with a corporate member of the Institution of Civil Engineers, and have passed the examination qualifying for A.M.I.C.E., or hold equivalent professional qualifications. Must be good draughtsmen, capable of designing and carrying out buildings, bridges and other engineering structures, and of taking out quantities and preparing detailed plans and estimates. Must be competent to execute surveys and to lay out and construct roads and have had experience as Civil Engineers on the construction of roads, buildings and other Public Works.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/15450. 6598

The Government of BOMBAY REQUIRE the SERVICES of TWO ASSISTANT MECHANICAL ENGINEERS,
both preferably possessing a recognised degree or diploma in Mechanical Engineering or equivalent qualification, for the Lloyd Barrage and Canal Construction, Karachi.
Appointment (A) candidates must possess practical experience of the maintenance and running of various types of steam machinery and should preferably have a working knowledge of steam navvies or dragline excavators.
Appointment (B) candidates must possess, in addition to the qualifications enumerated above, a thorough experience in the design and maintenance of Diesel and semi-Diesel machines, preferably with navvies or dragline excavators. Candidates for both posts must have served a five years' workshop apprenticeship and have had experience of pumping and steam or oil-driven lighting plant. Age in each case should not exceed 35 years, single men preferred.
Four years' agreement in first instance. Pay Rs. 1250-50-1500 per mensem and travelling allowances. First-class passage to India and return passage on satisfactory termination of services. Provident Fund. Rent free accommodation.
Forms of application and further particulars may be obtained upon request by postcard from the SECRETARY TO THE HIGH COMMISSIONER FOR INDIA, General Department, 42, Grosvenor-gardens, London, S.W. 1. Last date for receipt of applications 8th October, 1927. 6522

The Government of the PUNJAB REQUIRE the SERVICES of an
ASSISTANT SUPERINTENDENT for the Central Workshops at Amritsar.
Candidates should hold a recognised degree or diploma in Mechanical Engineering or equivalent qualification. They should have administrative experience and be competent to assist in the calculations and design of machinery for large irrigation schemes. Age about 27-32 years, single man preferred.
Five years' agreement in first instance. Pay in accordance with an age scale, e.g., age 27, Rs. 525 a month, plus overseas pay £15 a month; age 32, Rs. 725 a month plus overseas pay £25 a month. Provident Fund, with Government bonus of 100 per cent. of subscription. Free first-class passage to India and return passage on satisfactory termination of agreement. (Overseas pay and return passage admissible only to an officer of non-Asiatic domicile.) Strict medical examination.
Forms of application and further particulars may be obtained (upon request by postcard) from the SECRETARY TO THE HIGH COMMISSIONER FOR INDIA, 42, Grosvenor-gardens, London, S.W. 1. Last date for receipt of applications 18th October, 1927. 6575

Assistant Engineer Required by the GOVERNMENT of SIERRA LEONE for the RAILWAY DEPARTMENT, for two tours of from 12 to 18 months' service, with possible extension. Salary £480 for the first three years of service, then £510, rising to £920 a year by annual increments. Outfit allowance of £60 on first appointment. Free quarters and first-class passages. Liberal leave on full salary. Candidates, 25 to 35 years of age, must have had good experience as Civil Engineers on Railway maintenance, preferably in the Tropics, and should have had practical experience of building construction and steel work erection.—Apply at once in writing, giving brief outline of qualifications and experience, and stating age, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W. 1, quoting clearly at head of application M/73. 6574

University of London.
A COURSE of FOUR LECTURES on "HEAT TRANSFER IN RECIPROCATING ENGINES, INCLUDING INTERNAL COMBUSTION ENGINES," will be given (in English), with lantern illustrations by Prof. Dr. ADOLF NAGEL (of the Technische Hochschule, Dresden), at the INSTITUTION OF CIVIL ENGINEERS (Great George-street, Westminster, S.W. 1), on TUESDAYS and FRIDAYS, OCTOBER 11th, 14th, 18th, and 21st, at 5.30 p.m. At the first Lecture the chair will be taken by Sir Henry Fowler, K.B.E.
ADMISSION FREE, WITHOUT TICKET.
EDWIN DELLER,
6588 Academic Registrar.

University College of South WALES AND MONMOUTHSHIRE.
COLEG PRIFATHROFAOL DEHEUDIR CYMRU A MYNWY.
A SPECIAL CLASS in METALLOGRAPHY, suitable for persons engaged in Metallurgy, Mining and Engineering, will be held on SATURDAY MORNINGS at the University College, Newport-road, Cardiff.
The Class will commence on October 8th, 1927.
Particulars can be obtained from the undersigned.
D. J. A. BROWN,
Registrar.
University College,
Cathays Park, Cardiff.
September 26th, 1927. 6618

PUBLIC NOTICES

Bombay, Baroda and Central INDIA RAILWAY COMPANY.
The Directors are prepared to receive up to Noon on Friday, 21st October, TENDERS for the SUPPLY of :—
1. ELECTRIC OVERHEAD TRAVELLING CRANES, &c. ;
and up to Noon on Friday, 14th October, TENDERS for the SUPPLY of :—
2. POROUS LECLANCHE CELLS AND ZINC RODS.
Tenders must be made on forms, copies of which, with specification, can be obtained at these Offices on payment of 20s. each for No. 1 and 10s. each for No. 2 (which will not be returned).
The Directors do not bind themselves to accept the lowest or any Tender.
S. G. S. YOUNG,
Secretary.
Offices : The White Mansion,
91, Petty France,
Westminster, S.W. 1,
28th September, 1927. 6609

County Borough of Brighton.
TO BOILER MAKERS AND OTHERS.
The Corporation invite TENDERS for the REMOVAL of two existing BOILERS and SEATINGS, the CONSTRUCTION of new BRICK SEATINGS, FLUES, &c., and the CONSTRUCTION, SUPPLY and ERECTION of two CORNISH BOILERS and FITTINGS, at North Road Baths, Brighton.
Specifications and drawings may be obtained from Mr. A. B. Cathcart, M. Inst. C.E., Waterworks Engineer, 12, Bond-street, Brighton, on payment of a deposit of Two Guineas, which will be refunded upon receipt of a bona fide Tender not subsequently withdrawn, and the return of the documents.
Tenders, marked "Tender for New Boilers, &c., North-road Baths," must be delivered to the undersigned at the Town Hall, Brighton, not later than 12 Noon on Thursday, the 13th October, 1927.
JAS. H. ROTHWELL,
Town Clerk.
Town Hall, Brighton,
September, 1927. 6590

PUBLIC NOTICES

County Borough of Brighton.
TO MANUFACTURERS OF SOFTENING PLANTS AND OTHERS.
The Corporation invite TENDERS for the SUPPLY and ERECTION of a BASE EXCHANGE SOFTENING PLANT, with Regenerating Tank, Electric Motor and Pump and appurtenant Plant at North-road Baths, Brighton. The plant to be capable of softening 20,000 gallons of water to zero hardness between regenerations.
Specifications and drawings may be obtained from Mr. A. B. Cathcart, M. Inst. C.E., Waterworks Engineer, 12, Bond-street, Brighton, on payment of a deposit of Two Guineas, which will be refunded upon receipt of a bona fide Tender not subsequently withdrawn, and the return of the documents.
Tenders, marked "Tender for Softening Plant, North-road Baths," must be delivered to the undersigned at the Town Hall, Brighton, not later than 12 Noon on Thursday, the 13th October, 1927.
JAS. H. ROTHWELL,
Town Clerk.
Town Hall, Brighton,
September, 1927. 6591

State Electricity Commission of VICTORIA.
22-32, William-street,
MELBOURNE,
AUSTRALIA.
TENDERS are hereby invited for the MANUFACTURE, SUPPLY and DELIVERY for the Yallourn Brown Coal Works, Victoria, Australia, PLANT for the ELECTRICAL PRECIPITATION of BROWN COAL DUST in accordance with specification No. 27/85.
Copies of Tender form, specification, &c., will be available upon application to :—
THE AGENT GENERAL FOR VICTORIA,
Victoria House,
The Strand,
London, ENGLAND,
and
HERR J. KLITZING, BERGWERKSDIREKTOR,
Grube Marga,
Bei Senftenberg,
GERMANY.
CHARGE :—
£1 1s. for three copies of Tender form, conditions of contract and specification complete. This charge will be returned in the event of a bona fide Tender being received. Extra copies 10s. 6d. each, not returnable.
PRELIMINARY DEPOSIT :—
A preliminary deposit of £50 is to be lodged with Tender or at the Office of the Agent General for Victoria.
Tenders on prescribed form, properly endorsed and addressed, must be delivered at the Office of the Commission, Melbourne, not later than 12th December, 1927.
The Commission does not bind itself to accept the lowest or any Tender.
W. J. PRICE,
6607 Acting Secretary.

The Madras and Southern MAHRATTA RAILWAY COMPANY, Limited, 25, Buckingham Palace-road, Westminster, S.W. 1, invite TENDERS for :—
(i.) 1270 AXLE-BOXES for CARRIAGES and WAGONS (Cast Steel or Malleable Cast Iron).
(ii.) GIRDER BRIDGE SPANS of 6, 12, and 20ft. (an approximate total tonnage of 155 tons).
Tenders are due in as follows :—
No. (i.) by 2 p.m. on Tuesday, 18th October, 1927.
No. (ii.) by 10.30 a.m. on Monday, 24th October, 1927.
Tender forms obtainable at above address ; fee One Guinea each, which is not returnable.
The Directors do not bind themselves to accept the lowest or any Tender. 6573

The South Indian Railway COMPANY, LIMITED.
The Directors are prepared to receive TENDERS for the SUPPLY of :—
1. STEELWORK FOR BRIDGES.
2. IRON CHAINS.
3. SCREWING TOOLS.
4. GRINDING WHEELS, &c.
Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.
Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked :—"Tender for Steelwork for Bridges," or as the case may be, must be left with the undersigned not later than 12 Noon on Friday, the 14th October, 1927.
The Directors do not bind themselves to accept the lowest or any Tender.
A charge, which will not be returned, will be made of £1 for specification No. 1, of 5s. for specification No. 2, and of 2s. 6d. each for specifications Nos. 3 and 4.
Copies of the drawings may be obtained from the Offices of the Company's Consulting Engineers, Messrs. Robert White and Partners, 3, Victoria-street, Westminster, London, S.W. 1.
A. MUIRHEAD,
Managing Director.
91, Petty France,
London, S.W. 1,
27th September, 1927. 6610

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SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

ADVERTISER Desires to THANK All Those Who applied for the Position as Assistant Works Manager for Locomotive Works, and informs them the POSITION has now been FILLED.—Box 5898. 6581 A

WANTED, an ENGINE WORKS MANAGER for British-owned shipbuilding and marine engineering works abroad. Applicants should have previous experience of Works Management and good technical and general knowledge. Preference will be given to those having some Sea and Drawing-office Experience. Age not exceeding 35.—Address, "TECHNICAL," Wm. Porteous and Co., Glasgow. P3713 A

WANTED, Experienced and Fully Qualified RATE FIXER for Machine Tool and General Engineering Concern. Must be a good organiser and have held similar position.—Address, stating age, salary, &c., 6570, The Engineer Office. 6570 A

WANTED for Large Sugar Factory, Central America, good SECOND ENGINEER, with knowledge and experience for Erection and Maintenance of Electric Motor-driven Machinery; age about 30; contract three years. Passage out and home; board and lodging found. State salary required.—FORSYTH, Westward Ho, West Moors, Dorset. 6606 A

WANTED, SERVICES of a Good TRAVELLER to Sell on Commission a new Clear-way Screw-down Stop Valve, of use to every factory in the country.
Apply in first instance by letter, giving references, to E. C. BOWDEN-SMITH, 17, Victoria-street, London, S.W. 1. 6605 A

A MAN OF ABILITY is REQUIRED to GET ORDERS for NEW and RE-CONDITIONED MACHINE TOOLS by personal calls amongst proved connections. He must have a sound knowledge of the business, be of good appearance, sober habits, and be prepared to EARN MONEY, not take wages. Liberal terms will be offered. Applicants giving a concise record of their experience and earning ability will be accorded a personal interview.—Write, Box 135, at HORNCASTLE'S, 60, Cheapside, E.C. 2. P3688 A

ASSISTANT ENGINEER, Commencing Salary £800 per annum, REQUIRED for Undertaking Supplying Water to large city in Argentina. Applicants must have had considerable experience in the Design of Works and in General Construction, and possess good technical training.—Write, with copies of testimonials, to "ARGENTINA," c.o. Streets, 6, Gracechurch-street, E.C. 3. 6593 A

ASSISTANT WORKS MANAGER, About 35, Experienced in Plating, Loft Work, General Shipbuilding and Repairs; must be practical man and used to control of men. State salary and experience; copies of references.—Address, P3716, The Engineer Office. P3716 A

CEYLON.—FIRM of ENGINEERS REQUIRE FIRST-CLASS ASSISTANT MECHANICAL and ELECTRICAL ENGINEER REPRESENTATIVE and SALESMAN, to call on tea estates and other clients to obtain orders for estate engineering and electrical work of all kinds, including general stores, tools and hardware supplies, capable of superintending the installation and completion of all orders obtained. Motor car supplied.
Candidates must be single, 25 to 28, regularly trained engineers, presently holding responsible positions and willing to serve in any capacity required, must possess good electrical experience and qualifications, draughtsmen and be capable of training native mechanics and assistants; estimating, correspondence, machine shop, structural work, and marine experience an advantage.
Salary Rs. 500, rising to Rs. 650 per month, passage, 4 years' agreement, half-pay leave 6 months, provided further agreement entered into.
Apply, with copies of all certificates gained and credentials, on foolscap paper, with dates and schedule of experience since leaving school to date, stating in detail schools or evening classes attended, with dates and successes gained. Candidates must definitely state that they are single.
Address, 6582, The Engineer Office. 6582 A

CHEMICAL ENGINEER REQUIRED, with Wide experience in the design, erection and maintenance of Chemical Plant for a large factory in the Midlands. Applications will only be considered from those having up-to-date knowledge and experience in modern factories employing a large number of workpeople. Age, experience, and salary required.—Address, 6586, The Engineer Office. 6586 A

CIVIL ENGINEERING ASSISTANT WANTED in Consulting Engineer's London Office. Age 27 to 37 years. Salary £400 to £500. Must be A.M. Inst. C.E. and have had good experience on large Civil Engineering Works.—Address, P3684, The Engineer Office. P3684 A

CHIEF ENGINEER, MECHANICAL and ELECTRICAL, REQUIRED, having specialised knowledge of Extra High-tension Sub-station Equipment and Design.
Applications, stating age, nationality, salary required, full particulars of experience (mechanical and electrical), and where obtained, should be marked "Application, Private," and addressed to the MANAGER, The British Electric Transformer Co., Ltd., Hayes, Middlesex, England. 6583 A

FULLY QUALIFIED CIVIL ENGINEER of Standing REQUIRED to Take Complete Control of important Eastern Branch of British Consulting Civil Engineering Firm. Applicants must be members of the Institution of Civil Engineers, and experienced in all branches of Civil Engineering. Preference will be given to those who have practised on their own account. Salary and commission according to qualifications.—Applications should give full particulars of qualifications, with references, and should state age and salary expected, to be addressed 6564, The Engineer Office. 6564 A

MACHINE TOOL SALESMAN REQUIRED for Leeds and Sheffield districts; thoroughly familiar with modern Machine Shop Practice. State full experience, age, salary, which will be treated confidentially.—Address, P3703, The Engineer Office. P3703 A

REPRESENTATIVES REQUIRED for Newcastle area by Messrs. FILTRATORS, Ltd., Astor House, Aldwych, London. Applicants must have had previous experience as Engineer Representative; should preferably have connection with steam users. Liberal terms offered. Fullest particulars should be sent with copies of two references. 6652 A

STRUCTURAL ENGINEER REQUIRED to Fill a Senior Post with a British firm in India, having structural and general engineering workshops. Sound knowledge essential in Estimating, Design and Manufacture of all classes of Structural Steelwork and Bridgework; all-round organising and commercial ability required. Good prospects and salary offered to a really suitable engineer; age between 30 to 40.—Write, giving full particulars and qualifications, to Z.W. 271, care Deacon's Advertising Offices, Fenchurch-avenue, London, E.C. 3. 6612 A

TRAVELLER for U.K. WANTED by Important Yorkshire Machine Tool Firm. Permanent position, good salary and prospects for first-class man only. Strict confidence.—Address, 6579, The Engineer Office. 6579 A

WORKS MANAGEMENT.—PERSONAL ASSISTANT WANTED by Managing Director of large manufacturing concern. Must be qualified engineer with first-rate up-to-date experience of works management and production organisation under premium bonus system. Position holds possibilities of advancement. Age about 35. Only those qualified should apply, giving full particulars of education and career to date.—Address, 6615, The Engineer Office. 6615 A

SITUATIONS OPEN (continued)

YOUNG ENGINEER REQUIRED for Road and Sewer Work, to do Setting out and Levelling, prepare plans and sections and measure up work. Wages about £5 a week.—Write, stating age, experience, &c., to Box C.C., care of R. Anderson and Co., 14, King William-street, Strand, W.C. 2. 6611 A

WANTED, for London Office, Capable STRUCTURAL and MECHANICAL DRAUGHTSMAN, experienced in conveying and elevating plants.—Address, giving age, experience, salary required, and when at liberty, to 6614, The Engineer Office. 6614 A

WANTED, Good DETAILING DRAUGHTSMAN; also TRACERS, Engineering Works. London district.—Address, 6621, The Engineer Office. 6621 A

WANTED, Several FIRST-CLASS DRAUGHTSMEN, by a firm of Engineers. Experience in Water-tube Boilers and structural steel work an advantage.—Applicants should write, in the first instance, to 6559, The Engineer Office, stating age, experience and salary required. 6559 A

CAPABLE DRAUGHTSMAN (Young) REQUIRED by North of England firm for Centrifugal Pumps, including High-lift, also Small High-speed Engines. Practical experience essential. State full particulars and salary.—Address, P3692, The Engineer Office. P3692 A

CHIEF DRAUGHTSMAN and DESIGNER REQUIRED for Locomotive Works, to Take Full Charge small staff; preferably with experience of Internal Combustion Locomotives and a knowledge of Carriage Construction. Permanency to suitable man.—Address in confidence, stating age, experience and salary required, 6596, The Engineer Office. 6596 A

CRANE DRAUGHTSMAN WANTED; Must Have good experience all types of Cranes and also first-class structural knowledge.—Address, stating age and salary required, 6568, The Engineer Office. 6568 A

DESIGNER, Experienced with Sound Theoretical and Practical Knowledge of Electrical Engineering, experienced in design of electrical accessories, good organiser and disciplinarian, REQUIRED to TAKE CHARGE of DRAWING-OFFICE, South London district. Write, stating salary required, training, experience, references, age and when disengaged.—Address, P3720, The Engineer Office. P3720 A

DRAUGHTSMAN, Experienced in Design, Lay-out and Equipment of Chemical Plant. State full qualifications, age, salary, &c.—Address, 6597, The Engineer Office. 6597 A

DRAUGHTSMAN, Experienced in Steelwork Design, including Preparation of Detail and Working Drawings for all classes of buildings, REQUIRED in Constructional Engineer's Office in London area.
Experience in General Building Work an advantage.
Address, stating age, experience, and salary required, P3690, The Engineer Office. P3690 A

DRAUGHTSMAN, Having Sound Experience in designing and estimating quantities for Large Conveying and Elevating Plants, WANTED for Engineering Works in North Midlands.—Address, 6571, The Engineer Office. 6571 A

DRAUGHTSMAN REQUIRED, Experienced in Mechanical and Structural Work.—Address, 6572, The Engineer Office. 6572 A

DRAUGHTSMAN, Thoroughly Experienced in Cable Machinery and General Plant Work, REQUIRED by CALLENDER'S CABLE and CONSTRUCTION CO., Ltd., Belvedere, Kent. None but fully qualified applicants will be considered. 6608 A

DRAUGHTSMEN WANTED, Preferably with Experience on Aircraft Engine Design.—Write, stating age, full experience, and salary required, to BRISTOL AEROPLANE COMPANY, Ltd., Bristol. 6585 A

DRAUGHTSMAN.—Yorkshire FIRM of ENGINEERS REQUIRE the SERVICES of a DRAUGHTSMAN, with sound experience in the Design of Concrete-mixing Machinery. Give particulars of age, experience and salary required.—Address, 6560, The Engineer Office. 6560 A

EXPERIENCED ENGINEER DRAUGHTSMAN REQUIRED for large Textile Factory, Birmingham district; must have Engineering Degree and experience in General Engineering and Factory Layout, and be capable of Working out Alterations or Improvements in Looms. State education, experience, salary required and when free.—Address, P3704, The Engineer Office. P3704 A

JUNIOR DRAUGHTSMAN, with Knowledge of Patent Drawings, WANTED for London Patent Office. Commencing salary One Guinea weekly.—Address, P3685, The Engineer Office. P3685 A

SENIOR DRAUGHTSMAN REQUIRED for Well-known Firm of Structural Engineers in Manchester district. Must be good designer and also capable of carrying through contracts for Steel-framed Buildings, Bridges, &c.—Address, stating age, experience, and salary required, 6587, The Engineer Office. 6587 A

STRUCTURAL DRAUGHTSMAN for London Work; must be thoroughly experienced in Designing and Carrying Out Contracts. State age, experience and salary required.—Address, P3691, The Engineer Office. P3691 A

(A) TWO FIRST-CLASS BRIDGE and CONSTRUCTIONAL STEEL WORK DRAUGHTSMEN REQUIRED for Technical Office, Buenos Aires, Argentina. Commencing salary 400.00 dollars Argentine paper currency per month (approx. £400 p.a.); after one year's service 450.00 dollars per month, and on completion two years' service 500.00 dollars per month.
(B) TWO QUANTITY SURVEYORS REQUIRED for Technical Office, Buenos Aires, Argentina, capable preparing bills of quantities, working up prices, preparing specifications and contracts, with good knowledge Building Construction. Commencing salary 400.00 dollars paper currency per month (approx. £400 p.a.); after one year's service 450.00 dollars per month, and on completion two years' service 500.00 dollars per month.
(C) TWO ASSISTANT ENGINEERS (Unmarried) REQUIRED for Argentina. Sound technical education and engineering training necessary. Commencing salary 380.00 dollars Argentine paper currency per month (approx. £380 p.a.) with an increase of 50.00 dollars per month on rendering a satisfactory examination in the Spanish language.
Applications, in brief, outline of technical education, training and experience, without testimonials, for the above positions to be addressed to FOX and MAYO, Consulting Engineers, 155, Dashwood House, Old Broad-street, London, E.C. 2. 6576 A

WANTED, EXPERIENCED FOREMAN for Bridge and Constructional Steel Works; must have up-to-date knowledge of high class work. Age not over 40. Good references essential.—Apply, with full details of experience, to 2000, Sharp and Co., 14, Exchange-square, Glasgow. P3721 A

FOREMAN ENGINEER REQUIRED to Supervise Erection of large Well Pumps and Engines in England. Only men with previous experience of this class of work need apply. Give full particulars of plants erected, age, salary required, &c.—Address, 6461, The Engineer Office. 6461 A

FOREMAN TEMPLATE MAKER (WORKING) WANTED; accustomed to Setting-out and to Templates in Wood for Constructional Steel Framework, Roofing, Girders, Hoppers, &c. London (East) district.—Address, stating age, experience and wages required, P3687, The Engineer Office. P3687 A

TWO FITTERS REQUIRED for Erection on Site of Heavy Pumping Machinery and Engines. Give full particulars, including age, wage and class of plants previously engaged upon.—Address, 6462, The Engineer Office. 6462 A

SITUATIONS WANTED

A COMMERCIAL ENGINEER (36), A.M.I.C.E., A.M.I.M.E., workshop, design, inspection and sales experience with power plant and machinery REQUIRES POSITION as Sales Manager or Representative. Excellent business record.—Address, P3655, The Engineer Office. P3655

ADVERTISER (224) DESIRES PROGRESSIVE EXECUTIVE POSITION; practical knowledge of patternmaking, carpentering, draughtsmanship and rate-fixing; general knowledge foundry methods and building maintenance. Salary secondary consideration.—Address, P3706, The Engineer Office. P3706 B

AS RESIDENT ENGINEER on Heavy Bridge, Dock or Railway Work. Highest references.—Address, 6442, The Engineer Office. 6442 B

CIVIL ENGINEER, Age 27, Desirous to Obtain POST as DRAUGHTSMAN, or other Position of Trust; 6 years practical experience in all branches of Engineering. Highest references. Moderate salary.—Address, P3722, The Engineer Office. P3722 B

ENGINEER, Just Completed Pulverised Fuel Plant, OPEN for ENGAGEMENT similar work, construction or design.—Address, P3689, The Engineer Office. P3689 B

ENGINEER (38), First-class B.O.T. Certificate, diploma in mechanical engineering, 3½ yrs. in shops, 2 yrs. at college, 6 mths. in drawing-office, 8 yrs. in mercantile marine, 5 yrs. in Royal Navy (war period), 2 yrs. in oilfields, 2 yrs. in present position as resident engineer of an institution, DESIRES CHANGE.—Address, P3700, The Engineer Office. P3700 B

ENGINEER, 1st Class Board of Trade, EXPERT MOTOR, Engineer, Works Manager, Advertising and Sales Manager, SEEKS POSITION as TECHNICAL Advisor, MANAGER of Works, SALESMAN or ANY Position of RESPONSIBILITY. Salary £24 per MONTH minimum. One Month NOTICE REQUIRED. PERMANENT positions only considered.
Address, P3699, The Engineer Office. P3699 B

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For continuation of Small Advertisements see page 3.

A Seven-Day Journal

Accumulation of Water in Mines.

A REPORT of much importance to all mining engineers, miners and mine managers was issued this week by the Departmental Committee appointed in 1924 to inquire into the prevention of dangers in mines from accumulations of water. Some time ago, acting on an interim report by the Committee, the Mines Department drew up a scheme for the compilation of a new catalogue of plans of abandoned mines. The Committee now recommends that as soon as this new catalogue is available, mineowners and managers should be urged to make themselves acquainted with the old workings registered as being in the neighbourhood of their own pits. Reliance, however, should not be placed on the accuracy or completeness of the plans. In particular, plans made before 1887 should be regarded only as indicating the existence of old workings in the neighbourhood. and not as evidence of their actual position. The Committee recommends that the mineowner, agent or manager should be required to notify the Divisional Inspector of the approach of any working in any seam within 100 yards of the boundary of his mineral tract, and that concealment of any encroachment should be made an offence under the Mines Act. Dealing with the question of water barriers, the Committee rejects the suggestion that all such barriers should be removed or pierced so that safety may be secured by conducting the water to the lowest point and then raising it to the surface. It believes that the provision of effective barriers is a necessary part of mining engineering practice. A barrier subjected to a pressure of water left in a horizontal seam or in the direction of the dip in an inclined seam, should not, it adds, be less than, and in many cases should be greater than, 20 yards in width. The Committee also supports those who are against the abandonment of dams. Dams, it says, are necessary and serve a useful purpose. The position and dimensions of dams should be required to be marked in all plans in ink.

Textile Machinery for Germany.

ALTHOUGH complete and authoritative confirmation is still lacking, there would appear to be much more ground than was at one time thought for the reports current regarding a scheme under which German textile manufacturers are to purchase British machinery to the extent of £20,000,000. It is stated on trustworthy authority that for some time past the German Sewing Silk and Thread Manufacturers' Association has been endeavouring to obtain large credits to enable its members to purchase textile machinery. American machinery manufacturers, it is said, demanded too high a rate of interest on the credits, as did the German banks, which declared that they could not finance the scheme at a rate of interest less than 14 per cent. The Association thereupon opened negotiations with this country with the result that a holding company under the name of the General Trading and Finance Company was formed to carry out the scheme. The company, it is stated, has received the backing of several important English banks and is prepared to deliver textile machinery to German textile firms of good standing on credit extending over three to four years at a rate of 6½ to 7 per cent. for interest. The orders placed under the scheme are estimated to amount to about £20,000,000 in the course of the next ten years. On every order a deposit of 20 to 25 per cent. is to be paid, the balance being paid off in quarterly instalments. British textile machinery manufacturers continue to express themselves cautiously regarding the scheme. The point has been raised that assurances will be required that the orders having been placed on a satisfactory financial footing, the German Government will permit the machinery to be delivered.

Mutual Co-operation on the L.M S. Railway.

ON Friday of last week, September 23rd, the third joint conference between railway officials and railwaymen with a view to securing greater co-operation between the management and the employees was held at Leeds. The aims of the President of the Executive were explained at length by Mr. William Clower, the Chief Officer for Labour and Establishment, who was supported by representatives from the headquarters of the principal departments. Elected delegates of the three railway trade unions were also present. Two similar conferences had previously taken place at Liverpool and Manchester, and at all these centres Sir Josiah Stamp's invitation to formulate a scheme whereby closer co-operation could be obtained was favourably received, and resolutions welcoming the company's declaration were passed. It is understood that the next step to be taken will involve preliminary meetings in fourteen districts with a view to allowing officials from headquarters to meet with local officials and representatives of the men to determine how best the scheme may be furthered. A similar note of good feeling between the management and railway employees was evident at the annual railway carnival which took place at Belle Vue, Manchester, on Saturday last. Over forty-five thousand railway employees attended this meeting, at which Sir Edwin Stockton and Sir Ralph Wedgwood spoke on behalf of the railway employers. The railwaymen's trade unions were represented by Mr. A. G. Walkden, Secretary of the Railway Clerks' Association ; Mr. J. Bromley, of the Associated Society of Locomotive Engineers and Firemen ; and Mr. J. H. Thomas, of the National Union of Railwaymen, all of whom spoke.

White Star Line Appointments.

IN a journal note of September 17th we referred to the impending retirement of Mr. W. J. Willett Bruce, the superintendent engineer of the White Star Line. It is now understood that the directors of the White Star Line have appointed Mr. D. Galloway superintendent engineer at Liverpool. He will take up duty at the end of October. For some months Mr. Galloway has been at Harland and Wolff's yard at Belfast superintending the construction of the new Canadian Liner Laurentic, which it is expected will run her trials some time in November. Prior to his appointment to Belfast, Mr. Galloway was the chief engineer of one of the company's liners sailing from Liverpool. It is also announced that Captain E. L. Trant has been appointed to command the new Laurentic above referred to. Captain Trant, who was apprenticed with the firm of Gillison and Chadwick, of Liverpool, joined the White Star Line in 1898, and since 1919 has been in command of various ships in the fleet.

The Schneider Cup Race.

ON Monday of this week Great Britain for the third time succeeded in winning the annual seaplane race for the Schneider Maritime Trophy. The race took place off the Lido at Venice, and consisted of a flight seven times round a closed 50-kilometre circuit. The American entry was withdrawn some weeks ago and one of the British machines entered for the contest met with disaster soon after it arrived in the Adriatic. When the day of the race arrived there remained to compete in it three Macchi-Fiat machines, two Supermarine-Napiers, and one Gloster-Napier. The three Italian machines and the Gloster-Napier retired before completing the course. One of the Supermarine-Napiers, piloted by Flight-Lieut. Webster, finished first with an average speed officially given as 281·66 miles an hour, while the second, piloted by Flight-Lieut. Worsley, completed the course at an average speed of 273·6 miles an hour. The winner not only gained the trophy for this country, but actually broke the speed record for aeroplane or seaplane. Italy, like Great Britain now, has won the contest three times ; the United States has been successful twice, and France once. The speed of the winner has risen from 44·7 miles an hour in 1913, through 102·5 in 1920, to 246·49 in 1926. In 1922 a Supermarine machine won the trophy with a speed of 146·5 miles an hour.

New Railway Steamers.

NEW steamships involving an expenditure of close upon £300,000 are to be added to the cross-Channel fleet of the Southern Railway Company, and are to be delivered in time for next year's summer traffic. The service between Newhaven and Dieppe is to be improved by the addition of a new fast cross-Channel boat, the Worthing, which will be built by William Denny and Brothers, Ltd., of Dumbarton. She will be a twin-screw oil-burning ship, with a designed speed of 24 knots. The passenger accommodation will be arranged for 1100 persons, and sleeping accommodation for a total of 316 first and second-class passengers will be provided. Two new paddle steamers, the Merstone and the Portsdown, are to be built for the Isle of Wight service between Portsmouth and Ryde. They will be constructed by the Caledon Shipbuilding and Engineering Company, Ltd., of Dundee, and will have a length of 185ft., with a speed of 13½ knots, and passenger accommodation for 600 persons. The cargo service between Dover and Folkstone is to be improved by the addition of a new cargo boat, the Deal, which will be a sister ship to the Hythe. The new vessel will be built by D. and W. Henderson and Co., Ltd., of Meadowside, Glasgow, and will have a gross tonnage of 685, a speed of 15 knots, and a cargo carrying capacity of 500 tons.

The British Coal Industry.

A BODY in the United States, known as the American Institute of Economics, has recently been conducting an investigation into the conditions under which the British coal industry is carried on. Its criticisms have met with a prompt response from the British Coalowners' Publicity Department. In illustration of the alleged inefficiency of British coal mining methods the American report states that only one-fifth of our coal output is cut by machinery, as compared with two-thirds in the United States. The reply to that allegation is to the effect that, according to the annual report of the Secretary for Mines, 53 per cent. of the coal raised in Scotland is machine cut and 33 per cent. of that in Northumberland. In other districts the percentage varies, the use made of machines being tempered by the fact that mechanical coal cutters cannot be employed indiscriminately in all coalfields. In many mines, particularly in Wales, the nature of the coal is against their employment, for, as Sir Richard Redmayne stated before the Sankey Commission, the coal "will not stand to be cut." No sooner does the machine proceed to work on the face than the coal falls upon it. In the United States, Sir Richard assured the Samuel Commission, the natural physical conditions are on the average vastly more favourable to the use of mechanical cutters than they are in this country. The American Institute of Economics has also criticised the redundancy of our mines and has stated that there is no room for "several thousand" of those now being operated. The reply to that contention is that 98 per cent. of the British output is produced by 715 undertakings, and that even in the United States there is a surplusage of productive capacity. It has been estimated that if all the American mines worked all the year round instead of on the average for only nine months a year, the annual surplus of coal would amount to something like 200 million tons.

An Important Shipbuilding Order.

THE announcement that the West Hartlepool shipowning firm of Sir R. Ropner and Co., Ltd., has placed an order for six cargo vessels with four different shipyards on the North-East Coast has been received with general satisfaction in the North of England area. The new vessels, which form a part of no less than fourteen ships which are now building or are on order for the same firm of owners, have each a length of about 420ft. with a deadweight carrying capacity of about 9000 tons. The new ships are to be propelled by triple-expansion steam machinery. Two of the ships are to be built at Blyth by the Cowpen Dry Docks and Shipbuilding Company, Ltd., and two others by Smith's Dock, Ltd., of South Bank Yard, Middlesbrough. The machinery will be built by Blair and Co., Ltd., of Stockton-on-Tees, and by Smiths' Dock, Ltd. William Gray and Co., Ltd., of West Hartlepool, is to build a further ship, the engines for which will be constructed by the Central Marine Engine Works at West Hartlepool. Another ship will be built on the Wear by Sir James Laing and Sons, Ltd., at Sunderland, and George Clark, Ltd., of Southwick Engine Works, Sunderland, will supply the propelling machinery for this vessel. The order is looked upon as an indication of a possible revival of business in the shipbuilding industry, which at present is still suffering from the prolonged depression through which it has passed during the last few years.

A Record L.M.S. Non-stop Run.

ALTHOUGH during the summer the Scotch expresses of the London, Midland and Scottish Railway have been making regular non-stop runs between Euston and Carnforth, a distance of 236 miles, that non-stop distance was increased on Monday last, September 26th, when the 10 a.m. train from Glasgow to Euston made a non-stop run from Carlisle to London, a distance of 299 miles. The locomotive which drew the train, unassisted, was No. 6100 of the "Royal Scot" type, which was described and illustrated in THE ENGINEER of August 5th, and the train consisted of twelve bogie vehicles, one luggage van, and two kitchen cars, the approximate total weight of the fifteen vehicles being 420 tons. The run was made in three minutes under the scheduled time of 5 hours 45 minutes, Euston being reached at 6.12 p.m., and an average speed of over 52 miles per hour was maintained with a maximum speed over certain parts of the road of 74 miles per hour. The "Royal Scot" type of locomotive was designed by Sir Henry Fowler, the Chief Mechanical Engineer of the L.M. and S. Railway, and fifty engines of this class are now being constructed by the North British Locomotive Company, Ltd., at Glasgow.

Some Notable Launches.

THE past week has been notable for important launches which have taken place. On Tuesday there was launched from Vickers' yard at Barrow-in-Furness the new Orient liner Orford. She is a 20,000-ton vessel with a length of 658ft., and the fourth of her class to be added to the Orient fleet. The propelling machinery consists of twin-screw single reduction geared turbines, steam being raised in oil-fired boilers designed for a working pressure of 215 lb. per square inch. The Orient Steam Navigation Company is considering a slightly larger liner, for which the order will, it is hoped, shortly be placed. At Dumbarton, William Denny and Bros., Ltd., launched the first of the new cargo ships for Canadian Pacific Steamships on Tuesday, and a second ship of the same class took the water the following day at Armstrong-Whitworth's yard on the Tyne. These new vessels, which form part of an order for five cargo ships and four liners, are of particular interest because all are to be fitted with water-tube boilers of the Yarrow or B. & W. type, some of which will have mechanical stokers. Two Scotch boilers will also be carried. The twin-screw geared turbine machinery of the Parsons type will work at a pressure of 250 lb. and a total superheat of 650 deg. Fah. The ships have a length of 512ft. and a maximum deadweight carrying capacity of 13,000 tons. Normally about a deadweight of 11,500 tons will be employed in service.

An American Diary.

No. X.*

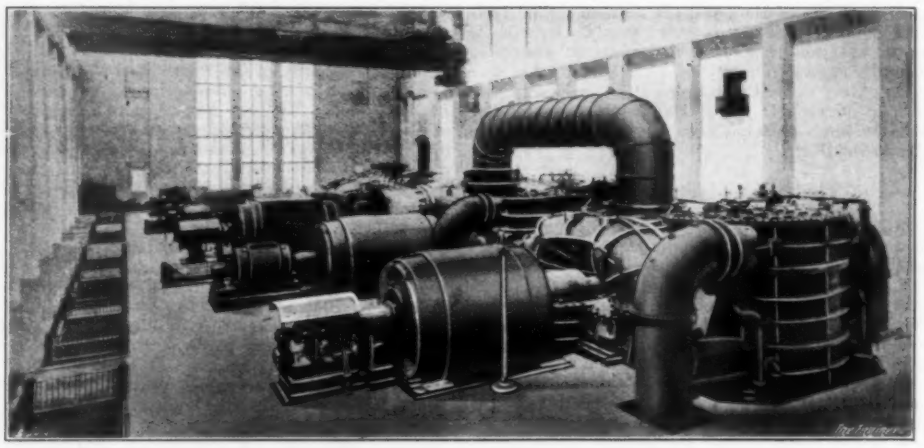
CHICAGO.

IF you ask the people of Chicago they will prove to you by statistics and geography that their city is destined to be the greatest metropolis in the world. They will tell you that it has already a population greater than that of Paris, and that its position in the centre of the United States, whence it may extend one hand to the industrial East and the other to the great prairies on the West and beyond the Rockies to the wealth of the Pacific Coast, gives it advantages which New York may envy.

If Pittsburg has the reputation of being the dirtiest city in America, Chicago has the reputation of being the wickedest—in the Eastern States at least. When the inhabitants of other cities, a little jealous perhaps of its rising influence, hear that you have been in Chicago they say "Oh!" in the tone of a Victorian addressing one who had visited Paris, give you what we believe is called in the best Cockney circles "such an old-fashioned look," and withdraw themselves a little as if to say, "He that toucheth pitch shall be defiled therewith." It may be true. Chicago may indeed be steeped in a veritable mulligatawny of crime, but the innocent visitor sees nothing of it. If it exists it is to be found in dark and backward abysses of the city, where the foreign bootlegging fraternities have staked out their claims and support them with the sandbag and the dagger. Elsewhere, along the great streets and all adown Michigan-avenue, one may wander with quite a reasonable expectation of not being suddenly hauled by roughs into a dark byway and robbed. And what a wonderful city it is! New York, Paris, even London, cannot show finer shop windows—notable for their artistic reserve—and surely Michigan-avenue has not many peers in the world. It is a one-sided street with the lake flanking it. Years ago the Illinois Railroad was built along the foreshore. As the city grew that was felt to be an intolerable privilege. But the railway was there, founded on its rights and not to be disturbed. Then the city authorities put their heads together and resolved, since they could not move the railway, to build a new foreshore out beyond that which Nature had given them. All the materials were at hand and the construction of that gigantic work is still going on. Bridges are being built over the railway and a magnificent road is being carried for miles along the margin of the lake.

CRAWFORD AVENUE AND CALUMET

Chicago receives its electricity supply from three stations of the Commonwealth Edison Company—Fisk-street, the oldest—1903—with vertical turbines, Calumet, and finally Crawford Avenue. Of the three the last-named is the most interesting, but at Calumet there are two experimental boilers which must not be overlooked. One, already in use, is a 200,000 lb. boiler of the B. and W. type, but with a far smaller proportion than usual of the familiar inclined tubes, the bulk of the evaporation being effected in the water walls of the furnace by radiant heat. This steam generator may be regarded as a step towards the second experimental boiler which was under construction at the time of our visit. It is a Wood radiant heat boiler and is virtually nothing more than a great box, of which the six sides are made of tubes. Five of the sides depend primarily upon the radiation from the hot gases, though some convection does, of course, take place, whilst the last side, through which the hot gases emerge, has several layers of staggered tubes and, possibly, absorbs more heat by convection than by radiation. It will be recalled that a boiler of this kind has been under trial at Manchester for a couple of years or so. We were fortunate enough to meet Mr. Wood himself in New York, and to have a chat with him about the problems of circulation which are presented by such a cubicular arrangement of tubes. It is difficult to see how the circulation can be anything but indeterminate—which every engineer abhors—but it would be premature to discuss that problem until the boiler is completed or the full designs are available. Mr. Wood himself is quite satisfied, from past experience, that the circulation presents no difficulties. The striking fact about the boiler is that it occupies far less space for the same output than a boiler of the normal type. The importance of radiant heat has long been recognised, particularly in connection with locomotive boilers, but full advantage could not be taken of it with solid fuel. With powdered or liquid fuel it is possible to maintain in the fire-box a vortex of brilliantly hot flame radiating its heat equally in all directions. The advantages which may be derived from that fact have, as yet, been but little explored, and Mr. Wood and the Combustion Engineering Corporation are to be congratulated upon the energy with which they are pursuing their investigations.



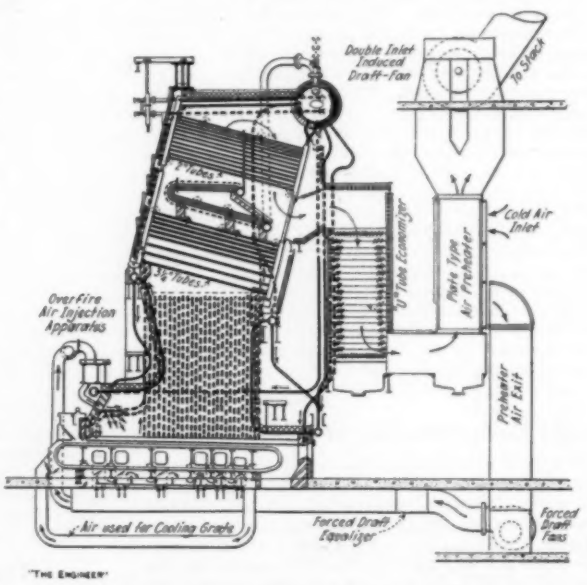
CRAWFORD AVENUE POWER HOUSE—TURBINE ROOM

Before speaking of Crawford Avenue itself a word must be said concerning a paper on that station which was presented and discussed at the spring meeting of the A.S.M.E. It was written by Mr. Alex. D. Bailey, superintendent of the generating stations of the Commonwealth Edison Company. As an example of what a paper for a technical society ought to be it could with difficulty be excelled. Authors only too often say nothing of the troubles and anxieties with which they are beset. Mr. Bailey took the opposite course. In his paper, which, by the way, we published *in extenso* in our issue of June 10th, 1927, he lays frankly before his brother engineers the difficulties which have been encountered in the development of a high-pressure, high-temperature station, he tells us of those things that have given trouble—steel castings and economisers—and of those which, sometimes in defiance of anticipation, have given none—such as the reheating boilers and steam joints, and he makes illuminating comments, born of actual experience, upon power station problems of to-day. We cannot but think that if all engineers would come forward as fearlessly as he has done and discuss the practical difficulties which they encounter in their daily work the profession as a whole would be the gainer.

Now as regards the station itself. It is, as we have already said, the latest of those in Chicago belonging to the Commonwealth Edison Company, and is of particular interest to English engineers because one of its 50,000-kW turbines was built by Parsons. It was started up in May, 1925, and is actually No. 1 unit, though No. 2 unit, a 60,000-kW set by the General Electric Company, was the first to be put into service—November, 1924. In March, 1925, a 50,000-kW set, by Westinghouse, was started and forms unit No. 3. Unit No. 4 develops 75,000 kW and was put on load in August, 1926. It was built by the General Electric Company. Another unit, No. 5, by the same makers, is to develop 90,000 kW and may be running by this time, and a sixth unit of 100,000 kW is now being constructed by the Westinghouse Company and should be ready for load about a year hence. That gives a total of 425,000 kW, but the projected ultimate capacity of the station is 750,000 kW.

In the first three units the steam is reheated before passing through the low-pressure turbine. The arrangement is practically the same as that at Columbia, already described. In the fourth unit reheating is not employed, not because the benefits of reheating are not appreciated, but because that unit was to be used under conditions of very variable load and the expense of the reheating plant could not be justified. In the fifth unit a totally different method of reheating is being used, the heat being drawn from the boiler steam instead of from the boiler gases. The whole installation is far less costly, and though the heat economy is a great deal less, only 3 per cent. as compared with 5½ per cent., the final economy will probably be as good, if not better.

A fact which strikes the visitor to Crawford Avenue is that chain-grate stokers are used throughout. These grates are no less than 24ft. wide in one piece, but they are compartmented so that the air supply may be modified to suit the condition of the fire. When the plant was first put in two shoots delivered coal to each stoker, but it was found that the supply was very patchy and the shoots have now been replaced by a single swinging shoot, which travels slowly backwards and forwards over the hopper. The boilers are of the B. and W. type and the furnaces are exceptionally high for stoker firing, the bottom row of tubes being something like 20ft. above the grates, giving a furnace volume in the neighbourhood of 6000 cubic feet. In the normal boilers there are 16,600 square feet of heating surface and 2700 to 3100 square feet of superheating surface. The reheating surface in the three boilers fitted with it is 14,000 square feet. The working pressure is 550 lb. at the turbines and between 600 lb. and 650 lb. at the boiler stop valves. Here is a section through a typical "normal" boiler at Crawford Avenue, taken from Mr. Bailey's paper. It will be noted that it is provided with water walls. On each side they present an area of 834 square feet, at the front 837, and at the rear 844. "It has been rather definitely determined," says Mr. Bailey "that there is a limit to the amount of water-cooled surface which can be installed in the furnace walls. If this is overdone the ignition of the coal is retarded, and the final burning out of the coal is delayed.



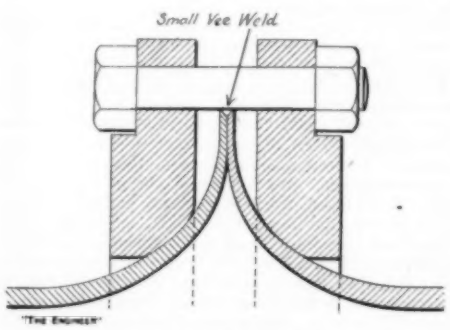
"THE ENGINEER"

GENERAL ARRANGEMENT OF NORMAL BOILER

* No. IX. appeared September 23rd.

The boiler equipped with a refractory-lined furnace apparently gives the best efficiency, but in order to maintain the high capacities necessary the maintenance of the refractory lining would be excessive and the furnace could not be operated continuously for long periods. It is evident, therefore, that a compromise will have to be made, and a furnace enclosed on three sides with water tubes alternated with rows of refractory and with a refractory arch will probably be not only the cheapest to install, but the most efficient." In the sketch a pipe marked "Air used for cooling grate" will not escape the attention. It was found necessary to fit it when air at 300 deg. Fah. was supplied under the grate, for the chains were unable to withstand the high temperature of combustion. In some of the boilers cooling is effected by passing the chains over water drums at the back.

The joints in the high-pressure steam mains are of the kind called Sargol, which is most easily described by a sketch. The load is taken by the flanges and bolts; the small vee weld ensures steam-tightness. The weld is easily opened with a chisel if necessary. Mr. W. L. Abbott, the Chief Operating Engineer of the company, told us that the design was perfectly satisfactory and never leaked. But the station has not been so fortunate with other connections and the economisers have given a great deal of trouble. Mechanical strains set up in the joints caused little leaks. The coal has, in Mr. Bailey's words, "devilish characteristics." It is full of sulphur—3·86 per cent.—the fumes from which, combining with the moisture, formed sulphuric acid, which led to rapid destruction of the economisers. It became necessary, therefore, not only to keep all the joints away from the gases—an obvious precaution—but to put up baffles packed tightly around the tubes so that no gas should even leak out and combine with moisture.

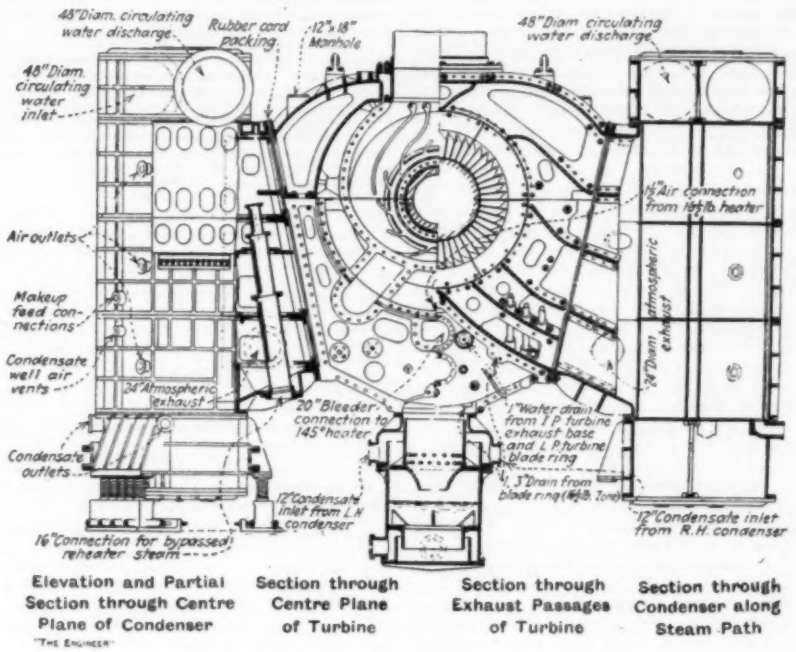


SARGOL STEAM-PIPE JOINT

We have already noted that the coal at Crawford Avenue is very poor stuff. The water supply is no better. It is taken from the drainage canal and contains sewage and dirt and other organic matter which congeals on the tubes. Hence cleaning is a very serious problem, and in order to minimise it the condensers are of the vertical type. The arrangement is interesting and unusual, and we give, therefore, a drawing which shows it clearly. The condensers, it will be seen, are of the two-pass type, the circulating water both entering and leaving at the top. The method of supporting the condenser on a number of helical springs should be observed. The tubes are expanded into the bottom plate and packed in the upper one, as at Columbia, and have given no trouble at all.

Crawford Avenue is such an interesting station that we are tempted to linger over it, but there is more to be done in Chicago, and we must leave it with regret.

(To be continued.)


48"Diam. circulating water discharge
Rubber cord packing
12"x18" Manhole
48"Diam circulating water discharge
48"Diam. circulating water inlet
Air outlets
Makeup feed connections
Condensate well air vents
24"Atmospheric exhaust
20"Bleeder connection to 145°heater
Condensate outlets
12"Condensate inlet from L.H condenser
16"Connection for bypassed reheater steam
1"Water drain from I.P. turbine exhaust base and L.P. turbine blade ring
3"Drain from blade ring
12"Condensate inlet from R.H. condenser
Elevation and Partial Section through Centre Plane of Condenser
Section through Centre Plane of Turbine
Section through Exhaust Passages of Turbine
Section through Condenser along Steam Path
"The Engineer"

SECTIONS THROUGH L.P. TURBINE AND CONDENSERS

Iron and Steel Institute.

No. II.*

Carnegie Gold Medals.

At the opening of the meeting on Wednesday, September 21st, the President called attention to the fact that the Carnegie Gold Medal had not been awarded for some years, owing to the war, but that the Council had now awarded Gold Medals in respect of papers read during the past twelve years. The Medals were awarded to Mr. J. H. Whiteley, for his contribution on the Eggertz test for combined carbon in steel, published in 1917; to Mr. F. Bainbridge, for his contribution on the effect of fluorspar on the solubility of basic slag, published in 1920; and to Mr. A. L. Curtis, for his contribution on steel moulding sands and their behaviour under high temperatures, published in 1925.

Silica Gel as a Blast Drying Medium.

The first paper taken was by Mr. E. H. Lewis, and dealt with the use of silica gel as a medium for drying blast. The following is a summary of the paper:—

The varying amount of moisture in the atmosphere and its effect on blast-furnace practice has, for a long time, been of interest to ironmasters. Half-hourly readings at Wishaw have shown a variation from 1·11 to 6·51 grains per cubic foot. Each 0·5 grain per cubic foot in the blast represents about 10 lb. of water per ton of pig iron made. In Scottish practice the weight of air used per ton of pig iron is about 10 cwt. more than the total weight of all other materials charged into the furnace, so that if much care is taken in selecting, sizing, and conditioning the other materials it seems only logical to get the air also into the best possible state.

The desirability of constant blast moisture is generally agreed, if such a result can be procured at a reasonable initial and running cost. Many attempts have been made, and processes suggested, to obtain such a constant blast, either by freezing or by absorption of the moisture chemically with calcium chloride, sulphuric acid, &c. A few years ago the use of silica gel was suggested. This material, which is now made in large quantities and of uniform quality, has wonderful powers of adsorbing water. At atmospheric temperature it can adsorb up to at least 20 per cent. of its weight of water from the air, and by raising the temperature this water can be driven off, leaving the reactivated gel ready for another cycle. It is not advisable to reduce the water content below about 5 per cent. In practice it is desirable to have about 2 lb. of gel for each cubic foot of air to be treated per minute.

A plant to treat 35,000 cubic feet per minute has been erected at the Wishaw Works of the Glasgow Iron and Steel Company, Ltd., and has been in operation since April 13th of this year. The plant contains six adsorber units. Each unit consists of a large steel box, in which are placed trays containing the gel in granular form. The bottoms of the trays are perforated, and the latter are so arranged in the box that the air passes through them in parallel. At one end of each box are valves communicating with the atmosphere or with the activating gases. At the other end are similar valves which allow either the air to pass to the blower or the gases and water vapour to pass to a small exhaust fan which is used for activating. Five units are normally used for adsorption while the other one is being activated. At the atmospheric inlet "Visco" filters are placed to remove the dust which is always found in the atmosphere of an industrial district, and which would, if pulled into the gel beds, tend to clog them and increase the suction—1¼in. to 2in. water gauge—necessary to draw the air through. The heat for activation is provided by the combustion of blast-furnace gas, which has been cleaned in the process of recovering the by-products from the raw coal used in the furnaces. The normal period for the activation of one unit is about 1¼ hours. During the latter part of this time the gas is turned off and air only is drawn through to cool down the gel and bring it to an efficient condition for adsorption. Between the dehydrating plant and the blower there is an adjustable inlet for atmospheric air, which is used for diluting the dried air up to the moisture figure aimed at. If this were not used it would be difficult to maintain a constant moisture

The costs of running such a plant are small. The only moving parts are the hand-operated valves and the motor-driven activating fan, which takes 20 H.P. The maintenance costs should also be low. There does not appear to be any loss of tar with the changed conditions. On the other hand, there is a slight diminution in ammonia recovery. Taking everything into account, the plant at Wishaw, so far, shows a substantial return on the capital cost.

In presenting his paper, Mr. Lewis gave one or two additional details of the silica gel plant and explained something of the nature of the gel. The action of the gel, he said, was a purely physical one. The gel was a precipitate of pure silica, and in appearance looked like barley sugar. As there were 2 lb. of gel to every cubic foot of air capacity, 84,000 lb., approximately, of gel were used, allowing for one unit in turn being out of commission for activating. The Wishaw plant was the first of its kind in the world applied in blast-furnace operation. It was not, Mr. Lewis added, the first time that his company had acted in a pioneering capacity in this country, for it installed the first gas engine for running on blast-furnace gas thirty-one years ago. In the course of his remarks, Mr. Lewis appealed to instrument makers to provide him with a hygrometer which would read directly in grains per cubic foot.

Mr. W. Simons (Guest, Keen and Nettlefolds, Cardiff) congratulated the author on his courage and judgment in introducing an entirely new process in the iron and steel industry. Extracting moisture from the air was not new, but the silica gel process was the first practical application for the purpose since Gayley read his paper in 1904. Half a dozen Gayley plants were put up in the United States, one in Cardiff and one in Germany, but it was significant that none of them, except the one at Cardiff, was in operation to-day, and the latter was only kept going because it was there and the capital expenditure on it had been wiped off. Even so, the Gayley plant at Cardiff was only worked during the summer months, owing to the cost of its operation. The feature of the silica gel plant was its simplicity, because the only working parts were the fan and the motor. In the Gayley system, there was a 300 H.P. engine working an ammonia compressor, brine pumps and condensing plant. Thus the silica gel process was a striking departure and would, he believed, reduce the cost of extracting moisture from the air very considerably. Although the author had remarked that in many cases the money spent upon systems of removing moisture from the air might have been better spent in other directions, such as improving the blast temperature, it must be remembered that the conditions at Wishaw were not quite the same as those at many other works, where coke was used and where blast-furnaces were contiguous to steel works, and where it was necessary to take full advantage of the waste heat for utilisation in the steel works. From that point of view, he was not sure that the author was quite right in saying that expenditure upon plant for removing moisture from the air might have been better spent in other directions. At any rate, it was very important in blast-furnace operation to get the highest efficiency in the stoves and to reduce the amount of gas used in the stoves in order to get as much surplus gas available as possible to reduce the fuel consumption in the works. This was particularly the case where, as under the conditions at Cardiff, it was found that the use of dry air reduced the value of the gas. Where only blast-furnace plants were in operation, there would undoubtedly be an advantage in drying the blast, although he had not yet found the advantage shown in the paper, namely, an economy of 10 per cent.

Mr. Benjamin Talbot said the previous speaker had given the key to the question when he spoke of the blast-furnace as really a department of modern steel plants. It was necessary to consider exactly the composition of the gas obtained from the blast-furnace, and if a bigger volume of gas could be obtained for use in the other departments, he believed it would give greater economy. In other words, the blast-furnace was a more effective gas producer than a separate gas-producing plant when the gas could be produced as surplus. Another consideration was the use of blast-furnace gas for gas engines. Again, it was necessary to consider the B.Th.U.s, and his view was that although from the theoretical point of view, the suggestion of cutting the fuel down to the absolute minimum was correct, from the practical point of view there was the consideration that having brought the fuel down to a minimum and introduced elsewhere in the plant other appliances, probably the full economical effect would not be obtained.

Mr. David Roberts, who also commented upon the

* No. I. appeared September 23rd.

simplicity of the silica gel plant, said that although it deserved very careful consideration, it could not be said definitely, until the process had been at work for some years, whether the results indicated in the paper would be borne out in practice. When the Gayley process was first described in 1904 in New York, it seemed to have a tremendous future, but unfortunately, because of the cost of working and for other reasons, that process had not been the success which was at first anticipated. Indeed, when he was in America in 1905 he had been told that the results anticipated had not been obtained in actual practice, and that those who were using the process were a little disappointed. Whether the same thing would take place with regard to silica gel or not, he did not know. Presumably, the great blotting paper effect of silica gel was caused by the fact that it was so exceedingly full of microscopic passages and pores that the actual superficial area of even a small piece was a considerable number of square feet. Whilst obviously the value of dry air must not be overlooked, it was necessary at the same time to pay attention to the improvement of blast-furnace working in this country generally, especially as to the use that was made of the gas obtained from the top of the furnace. To-day, in many works, the gas was not even cleaned, and, worse than that, when it was cleaned it was not efficiently used. When one visited works in Germany, America and elsewhere, where the most modern equipment was installed, it was impossible not to compare the efficiency of working there with the lamentable waste of gas from our own blast-furnaces. Mr. Talbot had suggested that the blast-furnace must be looked upon as a gas producer. It had been repeatedly stated that the coke used in our blast-furnaces was less than that used in Germany, but the reason for that was obvious. We had to watch our coke because the gas was wasted, whereas in Germany they did not waste a particle of it, so that it did not matter whether they used ½ cwt. or 1 cwt. of coke more.

Mr. J. Henderson said that no more important subject faced us in this country at the present time than the improvement of blast-furnace practice, but there was great difficulty in establishing cause and effect in such practice, because of the variable conditions, and it was therefore necessary to wait for some time to ascertain the actual results of the silica gel process. An important matter was the regularity in the quality of iron produced. Those operating blast-furnaces had to use a variable coke which, to a large extent, was outside their control. The same remark applied to ironstone, and in Lincolnshire the supplies of ironstone showed a great variation. He did not agree with the suggestion that the blast-furnace should be treated as a gas producer; on the contrary, every effort should be made to cut down the fuel consumption even at the risk of a deterioration in the B.Th.U.s of the gas or the quantity of it.

Professor C. H. Desch pointed out that the process of using some absorbing material for the moisture in blast-furnace operation depended entirely on the perfect reversibility of the drying agent, and he understood that experiments made in Germany with calcium chloride failed because the process could never be made perfectly reversible. A very slight overheating during reactivation spoiled the calcium chloride. The remarkable feature of silica gel was its perfect reversibility. He personally had had occasion to watch the behaviour of silica gel in entirely different experiments, namely, in the absorption of various organic vapours, and it had been proved that silica gel could be used for years over and over again on the absorption of all kinds of vapours. The original specimen of silica gel was taken after three years and subjected to the first experiment which had been made, and the absorption curve obtained was exactly the same as it was originally. There seemed no reason why silica gel should not remain good indefinitely. Whilst hesitating to criticise any statement made by Mr. Talbot, with his great practical experience, he thought it would be interesting to have thoroughly discussed his suggestion that we should think of the blast-furnace as a gas producer.

Mr. Guy Barrett emphasised the point that the statement in the paper that each 0·5 grain of moisture per cubic foot in the blast represented about 10 lb. of water per ton of pig iron made, must not be taken as generally applicable, because the actual figure depended upon the amount of ore per ton of pig iron. It was also stated in the paper that the drying required 7 tons of coal per day, but it would be more useful to have that figure expressed in the quantity of fuel consumed per ton of pig iron. One of the most important matters in blast-furnace operation was the regularity of conditions, and even though money could be spent profitably in raising the temperature of the blast, if there were savings to be made by adopting processes similar to that described in the paper, they were well worth making.

The President said he did not agree with Mr. Talbot's view, and urged the necessity for making pig iron with the least quantity of coke. The great advantage from de-hydrating the blast, however, was not so much the saving in fuel as the improvement in regularity of product, and especially in basic pig iron where low silicon was wanted. The idea that the blast-furnace plant, as a whole, should not be made efficient led to slovenly work, because the operators often felt that it did not matter how much fuel they used, and that did not conduce to economic working.

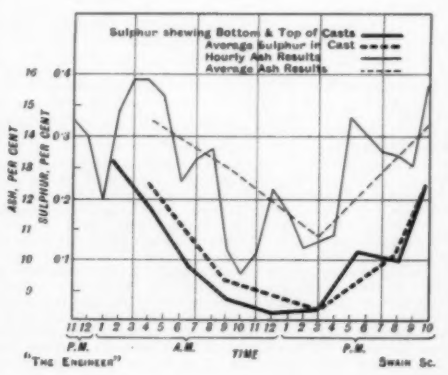
Mr. Lewis, replying to the discussion, and dealing with the simplicity of the silica gel plant, said that there was a 20 H.P. motor for pulling the activating gas through the units, the only other moving parts being hand-operated valves. When the experimental stage was passed there was no reason why the whole plant should not be looked after by a well-trained furnaceman, and not necessarily by a chemist. Several speakers had mentioned the remark in the paper that money expended on air drying plant would have been better spent in improving other conditions, such as increasing the blast temperature. That, however, was not a criticism of his own but a summary of criticisms that had been made by other people. His own view was that if in addition to getting the other improvements in blast-furnace operation it was possible also to get the advantage of the dry blast, it was worth while, but each case must be considered on its own merits. As to the 10 per cent. saving commented upon by Mr. Simons, he did not wish to overstate the case and put it no higher than that there had been a 10 per cent. saving in a normal July; he did not claim a like saving over the whole year. With regard to Mr. Talbot's remarks concerning the blast-furnace as a gas producer, it was necessary for those dealing with the matter to make up their minds whether it was better to use the furnace in that way or to have a separate gas producer plant. A point not mentioned by anybody was that if blast-furnaces were to be run as gas producers, they had better be run as efficient gas producers, and that could only be done by keeping a constant blast. That was possible with the silica gel process by the aid of the dilution doors. In that way one could run with a perfectly constant blast so that there were possibilities in the use of silica gel for regulating the blast, even if a dry blast were not required. The point as to the quality of iron was very important, because if the blast-furnaces, run as gas producers, were run with constant moisture in the blast—even if high—a very much improved quality of iron was obtained in addition to better running generally. Undoubtedly, as had been mentioned, there were many variables in blast-furnace practice and the only thing to be done was to pin them down one by one. He agreed with Mr. Barrett that the 10 lb. of water applied to the conditions at Wishaw only. The 7 tons of coal per day was required for a plant of 35,000 cubic feet. The plant was producing 2100 tons of pig iron per week, and the cost was 2½d. per ton of pig iron with coke at 10s. per ton. Actually it should not cost as much as that, because unfortunately they were not using the whole of the gas at Wishaw.

The President asked if activation could be carried out by by-passing some of the flue gas? Mr. Lewis said that that course would result in a rather complicated plant. That question and also the question of activating with heated air was gone into very carefully, and whilst the first alternative would have made a complicated plant, the second would have added considerably to the cost of the plant.

The Effect of Varying Ash in Coke.

A paper by Mr. C. S. Gill, entitled "The Effect of Varying Ash in the Coke on Blast-furnace Working," was then presented. The following is a summary of Mr. Gill's paper:—

Considerable attention has been given recently to the coke for blast-furnace use, and valuable investigations have been and are taking place in this country and in America, in order to define those attributes of blast-furnace coke which give the most satisfactory results in practice. As to which attribute of coke is the most important, it is not always easy to say. High ash or sulphur are either of them definite evils, but if they are regularly and consistently high, it is possible so to burden the furnace that the evil results are confined to increased expense in the production of the pig iron. On the other hand, a fluctuating ash is an unmitigated evil, as it is impossible so to arrange the burden that the furnace shall give reasonably consistent results if the ash in the coke is varying from hour to hour even to the extent of 1½ or



2 per cent.; and probably many practical operators would agree that they prefer a coke consistently carrying 12 per cent. of ash rather than one in which the ash fluctuates from 9 per cent. to 14 per cent.

Early in 1924 very serious trouble was experienced owing to the fluctuations in the quality of the iron from cast to cast. Repeatedly the quality would change from No. 1 grade to practically white iron within a few hours, and then back again to good iron. After the strictest supervision of the weighing of materials and the charging of the furnaces had revealed nothing wrong, the conclusion became inevitable that the root of the trouble must lie in the coke. Arrangements were made for hourly samples of the coke to be taken as it was being charged to the furnace over a period of twenty-four hours. From the dimensions of the furnace and speed of driving it was not difficult to calculate with tolerable accuracy how long it took the coke to reach the hearth of the furnace and, from this, to identify the cast or iron corresponding to the coke charged at any given time. The results are shown in the accompanying diagram. In view of the great difference in the quality of the iron corresponding to what might be considered a comparatively small variation in the percentage of ash, it should be remembered that each increase in ash not only reduces the percentage of total carbon in the coke, but increases the weight of slag formed, which in its turn requires an increased amount of carbon to raise it to its melting point and superheat it to the temperature of the furnace, so reducing considerably the carbon available for the other necessary chemical and thermal reactions of the furnace operation.

The following illustration is given as showing the effect of changing the ash in the coke supplied to the whole of the blast-furnace plant. The results are averaged over five weeks in each case. Period I. gives the figures for five weeks immediately prior to the change, and Period II., the corresponding figures for the five weeks immediately following the change, omitting altogether the week during which the change over was effected. The figures are actual averages of the results at a number of furnaces, and not of one selected furnace. Both cokes were similar in physical characteristics, being made in the same ovens, and under identical conditions.

	Period I.	Period II.
Average ash in the coke	12·15 per cent.	9·76 per cent.
Average weekly make of pig iron	3311 tons	3819 tons
Tonnage of No. 3 grade	210 tons	134 tons
Percentage of No. 3 grade	6·34 per cent.	3·51 per cent.
Average pressure of blast	5¼ lb. per sq. in.	4¾ lb. per sq. in.
Percentage increase in make	—	15·4 per cent.
Reduction in coke consumption	—	1·01 cwt. per ton pig

During both periods the endeavour was made to produce iron high in silicon for sale purposes, but during Period I. the furnaces were "stiff" and the results unsatisfactory, whilst during Period II. the furnaces worked freely and gave consistently good results.

On another occasion a similar change-over was made on one furnace only from a coke containing 12·5 per cent. of ash to one averaging 8·75 per cent. of ash, and the test was kept up for nearly five weeks. The following comparison was obtained:—

	Before change-over.	After change-over.
Percentage ash in coke	12·5 p.c.	8·75 p.c.
Average weekly make of pig iron	950 tons	1190 tons
Percentage increase of make	—	25·25 p.c.
Reduction in coke consumption	—	1·76 cwt. per ton pig

The Theory of the Blast-furnace Process.

The presentation of Mr. Gill's paper was followed by that of one entitled "On the Theory of the Blast-furnace Process," by Dr. Fritz Wüst. The following is the author's own summary of his contribution:—

In the oxidising gas phase in front of the tuyeres oxidation of the iron occurs, whereby the slag becomes charged with ferrous oxide. Therefore no reduction of manganous oxide, silica, and phosphoric acid from the slag can take place, for the reason that silicon, phosphorus, and manganese would immediately become re-oxidised by the iron oxide. The reduction of these oxides must therefore be effected above the tuyere level. Analyses of washed iron from five charcoal blast-furnaces and one coke blast-furnace prove this. Tests with silica, phosphoric acid, and manganous oxide resulted in the reduction of these oxides with elementary carbon in the presence of iron. Silicon, manganese, and phosphorus diffuse into the iron before melting in the same way as carbon, so that the iron is actually formed into pig iron before it melts. Hydrogen and carbon monoxide reduce only manganous oxide. For the reduction in the blast-furnace the principal agent is the carbon formed according to the equation $2\,CO = CO_2 + C$, which penetrates into the pores of the ore, thus specially tending to promote reduction.

Neither Mr. Gill nor Dr. Wüst were present. The two papers were discussed together.

Professor Henry Louis remarked that at the Coal Cleaning Conference in Edinburgh this year, it was stated by several leading people engaged in coal cleaning that if the coal user would pay sufficient to remunerate them, they could make it worth while to clean the coal. Mr. Gill's paper indicated how far it would pay to go in the matter of coal cleaning, because it showed a direct saving of 1s. 3d. per ton of pig iron made, with 3 per cent. of ash less in the coke. In addition, there were many indirect savings which it was perhaps difficult to calculate. For instance, 3 per cent. of ash less in the coke meant, roughly speaking, about 2 per cent. of silica less in the coke, and that meant something like 5 per cent. of limestone less in the blast-furnace charge, and something of the order, taking the average slag composition, of 6 tons of slag less to handle. In addition to that, there was the increased output from the blast-furnace, which meant saving in labour and saving in depreciation and amortisation of the blast-furnace plant, and a number of other items which he put, roughly, at 1s., which, added to the 1s. 3d. already mentioned, gave a total saving of 27d. per ton. With regard to the cost of coal cleaning to the degree mentioned, modern plants should not involve an expenditure of more than from 4d. to 6d. per ton. In addition, it was necessary to bear in mind that the amount of vendable coal produced was diminished by 10 per cent. Taking the coal as costing 12s. 6d. per ton at the pit, that meant an addition of 15d. to the 6d., or a total of 21d. to produce a saving of 27d. This was for a reduction of 3 per cent. in the ash, whilst with a 6 per cent. reduction the saving would be 54d., reckoning 1 ton of coke to 1 ton of pig iron in round figures. The paper threfore indicated the possibility of ample remuneration to the coal producer for cleaning his coal, and at the same time gave the blast-furnace man a strong inducement to pay for the cleaner coke.

Mr. J. Henderson said that calculations made at

the Frodingham works recently showed a saving of not less than 6d. per ton of pig iron made for 1 per cent. reduction in the ash content. This was the direct saving brought about by the use of cleaner coke, and did not cover the consequential savings mentioned by Professor Louis. Whether the results indicated in the paper would actually be obtained in practice, he did not know, but there was no doubt that a lower ash content in the coke was a matter of the highest importance.

Mr. E. H. Lewis remarked that three years ago in an address to the West of Scotland Institute he took the question of ash in coal as part of his subject, and calculated theoretically that taking into account the loss of carbon owing to the presence of ash, the loss in the by-product plant and the increased limestone necessary to flux the additional ash, each 1 per cent. of ash was worth 9·4d. per ton. At that time, 3 per cent. reduction would have meant 2s. 10½d. per ton less in the cost of manufacture of pig iron. The figure of 2s. 10½d. would be 2s. 2d. to-day.

Dr. R. Lessing, in a written communication, after mentioning that his investigations over a period of years had led him to the same conclusions as those arrived at by Mr. Gill, said that he considered reductions of ash content of a very much greater extent than those mentioned in the paper, viz., 3 per cent., were possible. The increments of savings would grow, the further the ash content was reduced, so that for a drop from 9 to 6 per cent. the saving in coke consumption might be considerably more than 1s. 3d. as for the first 3 per cent. Moreover, the sum total of the indirect saving due to increased output, more regular product, &c., which Mr. Gill considered to be "material," would be of an order of magnitude even larger than the saving from the lower coke consumption. The saving in capital charges alone, which would necessarily differ from case to case, might amount, on the basis of a 25 per cent. increase for a 3 per cent. ash reduction, to rather more than 1s. per ton of pig made, to which a few pence would have to be added in respect of the re-lining fund. The monetary value of an enhanced quality or regularity of the product was difficult to assess, but once the dependence of these factors upon the quality of the coke had been recognised, the tendency would be to insist on a fuel which would guarantee such quality regardless of any incidental saving that might be effected. The iron and steel industry would, in the near future, feel constrained to insist for its solid fuel on a coke containing only a fraction of the proportion of mineral matter which was customary to-day.

The President, closing the discussion, commented upon the importance of the question of reducing the ash content of coal, as sent out from the collieries, and asked those with experience of the matter to communicate their results to the Institute.

High-frequency Induction Melting.

The next paper to be read was one on "High-frequency Induction Melting," by Mr. D. F. Campbell. The following is an abstract of the paper :—

Induction heating was first applied to the steel industry about twenty-five years ago, and the theoretical work of Ferranti, Colby, and others resulted in industrial furnaces being developed by Kjellin, Frick, and Rodenhäuser.

Although a few of these furnaces are still used, many have been abandoned on account of certain inherent difficulties in their metallurgical and electrical characteristics. In most cases, special low-frequency generators are used to obtain a reasonable power factor, and these are both expensive and large, while the generator capacity cannot be used for general works purposes in cases of emergency, owing to the exceptional periodicity. Metallurgically, the ordinary induction furnace has serious limitations; the molten metal is contained in a hearth of complicated form with a large area of refractory material exposed to the steel, which involves high maintenance cost and lack of homogeneity in the steel, while the slag is only melted with difficulty, so that efficient refining is impossible. It is also necessary to leave, or place, a quantity of steel in the furnace after each heat to form the secondary connection, which is a serious difficulty when making alloy steels, as the weight of steel cannot be determined with sufficient accuracy to work to close specifications, and the change from one quality of steel to another is difficult. In the case of high-frequency induction furnaces the crucible can be completely emptied after each heat.

With the ordinary low or standard frequency furnace it is necessary that the bath of molten metal should be annular in form so that it may surround and form the secondary of one or more iron transformer cores, but in the case of high-frequency furnaces ironless induction is used and heat is generated by eddy currents, so that a cylindrical or spherical bath can be used—the ideal form of metal container for metal melting—and no iron core is required. A low power factor is characteristic of the high-frequency design, but this is easily corrected to any desired extent by the use, in the case of the Ajax-Northrup furnace, of condensers at a reasonable cost and efficiency.

Obtaining machinery for the production of high-frequency currents at reasonable cost in sufficiently large units was the problem which had to be solved before the industrial use of the furnace could be assured. This difficulty has now been entirely overcome, and high-frequency rotary generators can now be obtained at reasonable cost from a number of British and foreign manufacturers. With this equipment the furnace installation is simple. The furnace itself is of remarkably simple construction and consists of a crucible or metal container, surrounded by about an inch of heat-insulating sand; around this a helical coil is wound, which is usually maintained at a low temperature by circulating water. This coil is the inductor carrying the water and high-frequency current, and the heat is generated within the metal itself inside the crucible, so that the walls merely serve the purpose of a container, and no heat is passed from the outside of the crucible to the metal within. No mechanical strength is required, as the crucible is always well supported by the packing of sand and it is not withdrawn for casting. The inductor coil is built into the furnace body, which is made of wood or other material in which heat will not be produced by induction. The body, which is easily replaceable, is generally fixed in a cradle arranged for nose tilting by electric motor, so that there is little or no movement of the crucible spout during teeming operations.

The metallurgical characteristics of the furnace are interesting, and some operations that were impossible in the past, such as the remelting of stainless iron without absorption of carbon or sulphur, can now be accomplished. Heating and melting are effected very rapidly, as induction heating makes it possible to generate heat throughout the charge of metal simultaneously, instead of heating from the surface only, as is the case with all fuel furnaces. The steel is made under crucible conditions, with the advantage of absolute homogeneity and an intensity of mixing and a melting temperature which is only limited by the refractories and the melter operating the furnace.

In high-frequency furnaces the electric current causes a very rapid rotating movement of the metal in the vertical plane, the speed of rotation being so great that in a bath of steel 18in. in diameter the centre of the bath rises more than 1in. above the metal at the circumference. This rapid circulation of the metal in contact with the slag quickly refines the metal, the heat transference between the metal and slag being sufficient to maintain the latter in a fluid condition, and to ensure that intimate contact which is so essential to rapid and efficient refining. For example, a bath of steel containing 0·7 per cent. of carbon was left in contact with a slag containing oxide of iron for ten minutes and the carbon was then reduced to 0·24 per cent.

The scope of high-frequency heating is expanding as rapidly as electrical machinery constructors can meet the requirements imposed upon them, and progress both in melting and heating of steel is being rapidly accomplished. Its value is, however, already well established as a method of making crucible steel of remarkable homogeneity at a low cost, with the elimination of the hard physical labour inseparable from present methods.

The President remarked that he had seen the furnaces referred to in the paper a fortnight ago, and it was most interesting to see the molten steel pouring out of a furnace encased in a wooden box. The temperature outside was so low that there was not the slightest risk of the wooden casing becoming ignited, and yet there was the molten steel in the crucible. The heat was, to all intents and purposes, generated in the centre of the mass, and there was no question of any impurity getting in.

Professor C. H. Desch (Sheffield University), after describing himself as a strong believer in the principle of high-frequency heating, said that although he had not seen the author's furnace at work, he had seen high-frequency induction furnaces working in America very successfully upon nickel alloys. He had had considerable experience of an earlier type of the Ajax-Northup class of furnace, which was used at Sheffield University for experimental melts and proved extremely satisfactory. By its means, it was possible to melt metals at very high melting points in a very short time without danger of contamination. At Sheffield University they made their own crucibles, and they did not need to be strong, as they were packed in zirconia sand, so that a cracked crucible did not cause a mishap. To melt 10 lb. of pure Swedish bar occupied little more than half an hour, and the loss of heat was extraordinarily small. When it was melted it was possible to take the lid off the crucible with the bare fingers. The lid was then just getting uncomfortably hot. The great achievement of the author was that he had brought the frequency of operation of the furnace to about 500, whereas the frequency in the case of previous furnaces of the type had been several thousand. That reduction in the frequency did away with troublesome spark gaps, and enabled a motor generator to be used. From the metallurgical point of view, he uttered a word of warning concerning the melting of the highest class of steels. The really essential factor was the killing required at the end of the operation. For some time the steel in the crucible was in a perfectly tranquil state, and the tiny particles of slag which floated to the top were removed as buttons. Towards the end of the melting operation with high frequency, the metal was in a turbulent condition, and the convection currents in the slag were so violent that there was a very great difference of level at the top, which prevented the elimination of small slag particles. As soon as the current was shut off, the metal cooled very rapidly. At the same time, there was the great advantage with high-frequency heating that there was no contamination from furnace gases, and as there were no carbonaceous materials in the crucibles, it was possible to start with quite pure metals. It was even possible to encase the whole apparatus in a vacuum so that it should be possible to manufacture steel without slag being introduced. In that case the turbulence of the molten metal would not be a difficulty.

Mr. E. H. Saniter asked to what temperature it was possible to raise steel in the high-frequency furnace, and Mr. L. Rothera expressed satisfaction at the design of a machine which did away with the use of spark gaps.

Mr. Campbell, replying to the discussion and dealing with the turbulent motion referred to by Professor Desch, said that he had been carrying out some experiments upon that point, because some people had imagined that the violent action would cause oxidation. In the experiments use was made of aluminium foil, which was easily oxidised, and it was found that the molten metal became covered with a skin of alumina, which did not break during the melting operation, and that skin protected the metal. The temperature to which metal could be raised in the furnace was almost anything. The difficulty was to know what the temperature was. The operation of the furnace required a certain amount of skill, but with that degree of skill it was possible to control the temperature simply by means of a rheostat, and the melter had nothing else to attend to. It was a far simpler job than with an arc furnace. The plant consisted of only one moving part, namely, the motor generator. The condensers were merely tanks of oil containing packets of tissue paper and aluminium foil, and there were a few controlling instruments. The equipment could be put into any works with the confidence that it could be maintained in regular operation. The question of the crucibles was an interesting one. It was true that it did not matter if a crucible broke because the metal was held up by the packing behind the crucible, and it sometimes happened that the crucible broke before the packing had had time to get heated, and fritted against the crucible. Even then, although the metal passed through the bottom of the crucible, the loss was not excessive, because the metal was caught by the copper coil outside the insulating sand. In that case there was no difficulty in cutting a section out of the copper coil and inserting a new one. The temperature was not above 80 deg., so that if 300 lb. of metal went through the bottom, there would probably only be a quarter of an hour's delay whilst a new section was put into the coil and a spare box and crucible put into use. There was no serious short circuit when the bottom came out of a crucible.

The President asked how long it was possible to maintain the temperature in a charge of 300 lb. or 400 lb. In the ordinary way the metal cooled very rapidly.

Mr. Campbell said it was possible to keep that quantity of metal hot for twenty-four hours without difficulty. The heat insulation was extraordinarily good if zirconia sand were used; ganister and silica sand were not so good. At the same time, there was no need to maintain the heat because the current could always be turned on and the heat could be regulated to any desired degree. The President, in proposing a vote of thanks to Mr. Campbell, said that when he saw the furnace, the bottom fell out of the crucible, but another one was working in a quarter of an hour.

Nickel-Silicon Iron Alloys.

A paper entitled "The Influence of Nickel and Silicon on an Iron-Carbon Alloy," by Dr. A. B. Everest, Mr. T. H. Turner and Professor D. Hanson, carried over from the previous day, was presented as the concluding item of Wednesday's programme. The following is the authors' own summary of the paper :—

The influence of nickel and silicon on an iron-carbon alloy was investigated over ranges of nickel between 0 and 40 per cent., and of silicon between 0 and 3·6 per cent. Nickel was added to the iron in the crucible as nickel-silicon shot; the method was effective and the loss of nickel was negligible.

The original iron-carbon alloy was white and unsound. Small additions of nickel rendered this iron first sound, then grey. It was established, however, that although the action of small amounts of nickel was similar to that of silicon, nevertheless the production of a given degree of graphitisation required about four times as much nickel as silicon. Nickel, therefore, reduced the tendency of the iron to chill.

Nickel and silicon, separately or together, tended to graphitise about 50 to 60 per cent. of the carbon in 1in. thick sand castings of this alloy. The graphite produced by the action of nickel was, in general, finer than that produced by silicon. Nickel additions to a silicon iron tended to refine the graphite. The addition of nickel tended also to produce a finer pearlite or to render it sorbitic.

Above about 5 per cent. of nickel the alloys became hard and unmachinable, due to the formation of martensite. This condition persisted up to about 18 per cent. of nickel when the alloys became austenitic, soft and non-magnetic, the latter property being most marked at 20 per cent. of nickel and 1·3 per cent. of silicon. Beyond 20 per cent. of nickel the alloys remained soft, but they became increasingly magnetic again.

In the presence of high silicon, more nickel was required to produce the changes of the matrix through sorbite and martensite, than in the case of low silicon. Silicon thus appeared to mask the effect of nickel.

The hardness curves for the alloys corresponded to the microstructures, showing softening during graphitisation, hardening through the sorbite and martensite ranges, and finally softening to the austenitic condition. Consequently chilling softened the alloys towards the end of the martensitic range.

The densities of the alloys examined were high for grey irons, but all lay between the limits normally given for white and grey irons.

Annealing at the proper temperatures rendered most of the unmachinable alloys machinable through the tempering of the martensite. The nickel-silicon irons were unstable on heating, but not so much so as the ordinary silicon irons. In high-nickel alloys graphite was precipitated from the austenite, which tended to become martensitic, but remained machinable.

Tests on the resistance of the alloys to corrosion in sulphuric acid showed that with small additions of nickel the alloys were more rapidly corroded than an ordinary cast iron. High additions of nickel, however, rendered the alloys austenitic, and great resistance to corrosion was shown.

Professor C. H. Desch said that he had visited the laboratory of the International Nickel Company at New Jersey in the spring of this year, and found work going on there on the influence of nickel on cast iron, but it had not gone so far as the authors had carried theirs. The paper afforded some accurate information as to the effect of nickel on cast iron concerning which a great deal of inaccurate work had been published in the past.

Mr. T. H. Turner said that although his name appeared as one of the authors of the paper, that was really in friendly acknowledgment of the fact that he happened to suggest the research which had been carried out by the aid of a generous and unconditional grant from the University which he happened to be instrumental in obtaining. All the work had been done by Dr. Everest under the direction of Professor Hanson. The reason why he thought the research necessary was that he had satisfied himself on the spot that nickel was being added to commercial cast irons in ordinary every-day routine works practice in many of the best North American foundries. The additions were made in relatively small quantities to high grade cast iron, but so far as he was aware a similar practice did not exist in Europe, and the published data were so contradictory that it was not wholly reliable. When he looked round to see why the practice existed he found that the

Americans were using a low total carbon by diluting their cast iron with steel scrap, that the normal irons had a low phosphorus content, and that when they added nickel they reduced the ordinary silicon content. In all the American works he had visited the nickel was added in the form of a low melting point alloy, and so far as he could see, the work that had been done by Dr. Everest confirmed the results of the American workers as regarded the influence of nickel and silicon. His work also confirmed the fact that nickel could be added successfully to cast iron in the form of a low melting point alloy. Nickel-silicon shot was used by Dr. Everest, and that was worth mentioning, because, whilst Dr. Everest had been carrying out his work, a European experimenter had endeavoured to add nickel to cast iron in the form of pure nickel shot placed in the bottom of the ladle but with unsuccessful results. That difference between success and failure might really be the explanation of the varying results obtained in the experiments recorded in the literature referred to in the paper. It was hoped to carry out further experiments to show the influence of phosphorus, chromium and total carbon variations in conjunction with similar additions of nickel. Those results would be awaited with interest because a paper had been published two months ago showing that small test pieces of cast iron could be made with a tensile strength of 47 tons per square inch containing approximately 3½ per cent. nickel and ½ per cent. chromium. Increased mechanical strength of that order would be of importance in connection with aero-engines, Diesel engines, steam engines, automobile engines, and resistance grids, and with many other special uses of cast iron. Those uses might not provide a very big tonnage, but they were important in modern engineering development, and it was in that direction that it was hoped the paper would be of ultimate value.

Professor Hanson said that it was not desired to suggest that nickel could be added to iron only in the form of a nickel-silicon alloy. As a matter of fact, both in America and here, it had also been added successfully in the form of pure nickel shot in the ladle and small ingots of pure nickel in the cupola. The use of the low melting point alloy was, however, easier, and there was no reason to suppose that if nickel were added in the pure form any superior or inferior results would be obtained.

Mr. W. T. Griffiths (Mond Nickel Company) remarked that nickel could be added to cast iron in other forms than that mentioned in the paper, and, as mentioned by Dr. Hanson, it was being so added both in America and in this country. Apart from that point, however, he wished to give two warnings especially to users of nickel as an addition to cast iron in this country. The first was, that having heard of the successful addition of nickel to cast iron in other countries, we must not expect to find it immediately an easy problem to get the same results here by adding nickel to any cast iron. There were wide differences between the cast irons used in America and those used here, and a considerable amount of research might be necessary before we could define the best conditions under which nickel could be added to British cast iron. The second warning was that having added nickel to cast iron in this country and not immediately obtained success, we must not at once come to the conclusion that the addition of nickel to cast iron was useless. It was only by such work as that recorded in the paper that we could ascertain the best methods by which we could obtain the undoubtedly good results produced by adding nickel and chromium to both American and British cast irons.

Lack of time prevented Dr. Everest from replying to the discussion, and the meeting was adjourned until the following day, Thursday, September 22nd.

(To be continued.)

The Lanarkshire Hydro-Electric Power Scheme.

No. I.

THE history of the Clyde is a splendid record of achievement won against formidable natural disadvantages. By constant dredging and engineering skill, it was converted from a neglected and meandering stream into one of the world's most important water highways. In its upper reaches it is a dream of beauty, whilst in sad contrast is the drab and ugly appearance it presents as winding its way to the Broomielaw it passes through the neighbourhood of the "black country" bordering on Glasgow. Years ago there was no more favourite outing for pleasure-seekers from Wishaw and the adjacent industrial towns than the Falls of Clyde. Of the Clyde's three falls—Bonnington, Corra Linn and Stonebyres—the easiest of access from the industrial centres is the latter. Two or three miles further up the river from Stonebyres are the Corra Linn and Bonnington Falls, which are separated only by a short distance from one another.

In the past, the Falls of the Clyde were a source of pleasure to the artist, the tourist and the rambler, and their passing removes an ancient landmark. No longer, however, can natural power resources be neglected, and in utilising these falls the Clyde Valley Electrical Power Company and its associated company, the Lanarkshire Hydro-Electric Power Company have done for the upper reaches what others have done for the lower reaches of the Clyde. The scheme is one of those dealt with in the report issued by the Water Power Resources Committee in 1921, embodying the report prepared by Mr. Walter G. Coles and Mr. A. G. Ingham, who was closely identified with the constructional work and associated with Buchan and Partners, the consulting engineers of Edinburgh, to whose plans and specifications the work was carried out. For the civil engineering work, Sir William Arrol and Co., Ltd., were responsible, whilst the English Electric Company's engineers acted as general hydraulic advisers and designed, built and erected the

FIG. 1—BONNINGTON HYDRO-ELECTRIC STATION

whole of the hydro-electrical equipment. Before dealing with the engineering details of the hydro stations, we will consider the scheme in a general way, leaving the engineering features of the power stations for a subsequent article.

There are two hydro stations, Stonebyres and Bonnington, and at the time of writing the latter, which is shown in Fig. 1 and Fig. 8 on page 370, and which is operated under the combined head of two waterfalls, Bonnington and Corra Linn, is about to be set to work, the Stonebyres station having been running some little time. These two falls are situated approximately 1000 yards apart. The Stonebyres station, which is illustrated in Fig. 9 on page 370 and its surge tank in Fig. 3, utilises the energy of the Stonebyres falls. The general lay-out of the two stations is very similar, such differences as occur being simply in detail and arise from variations in local conditions, as tabulated below. Both stations belong to the Lanarkshire Hydro-Electric Power Company, and they will work in parallel with the steam stations of the Clyde Valley Electrical Power Company. During normal times of flow the hydro stations will produce all the power they can, thereby reducing the demand on the steam stations.

Power station	Bonnington.	Stonebyres.
Available head, in feet	189	97½
Size of unit, kW	4920	2840
Plant capacity, kW	9840	5680
Diameter of tunnel	10ft.	11ft.
Diameter of pipe lines	6ft. 6in.	6ft. 6in.

The water which flows over the Bonnington Fall is collected on a gross catchment area of 360 square miles, from which must be deducted an area of 29·4 square miles, representing the gathering grounds for domestic water supply of the Lanarkshire County Council and other Lanarkshire local authorities, leaving a net effective catchment area of 331 square miles, the average rainfall over this area being 43in. per annum. Stonebyres station, situated about 3 miles further down the river than the Bonnington station, obtains its water from a catchment area 54 square miles additional to that supplying the Bonnington plant. The total gross catchment area of this station is therefore 414 square miles, from which, however, must be deducted the gathering grounds of the Lanarkshire county and burgh authorities, leaving a net catchment area of 385 square miles, having an average annual rainfall of 43in. As the diagram, Fig. 4, indicates, the quantity of water carried by the Clyde varies widely with the seasons. The extent of these variations is shown by this diagram for the years 1914, 1915 and 1916, and records extending over a period of sixteen years indicate that the year 1914 can be taken as an average.

The water from the river is trapped by means of automatic tilting weirs or gates, shown in Figs. 5, 6 and 7, and in Figs. 10 and 11 on page 370, which show the Bonnington and Stonebyres weirs respectively. These weirs automatically adjust themselves to suit the varying conditions of flow obtaining in the river from day to day, and they maintain within specified limits a constant water level. Both at the Stonebyres and Bonnington falls these weirs operate on the same principle, and are built on very much the same lines, but whereas at Bonnington the counterweights are attached to rocking arms—as shown in Fig. 6—at Stonebyres rope wheels are employed, as shown in Fig. 7 and in Fig. 11 on page 370. The Bonnington weir—see the drawings Figs. 6 and 5—consists of three automatic tilting gates fixed to a concrete sill on knife-edged pivots, giving an average level in the head bay of 566ft. O.D. When the river rises above this figure of 566ft. O.D. the tilting gates are automatically depressed by the extra weight of water, and their new position allows of an increased flow so that the river level is brought down again to 566ft. O.D., thus guarding against undue flooding, whilst when the highest flood level occurs the weirs are lowered completely down to the river bottom, i.e., to the elevation 562ft. O.D. The counterweights are arranged to ensure that the tilting gates will not rise during flood water, but immediately the river level drops again the gates return to their normal inclined position. The upright concrete pillars from which the Bonnington gates are hung support a 10ft. reinforced concrete roadway capable of carrying 10 tons and over which a vehicle may be taken for the purpose of transporting any of the heavy material needed at the weir and intake, such as gates, screens, &c.

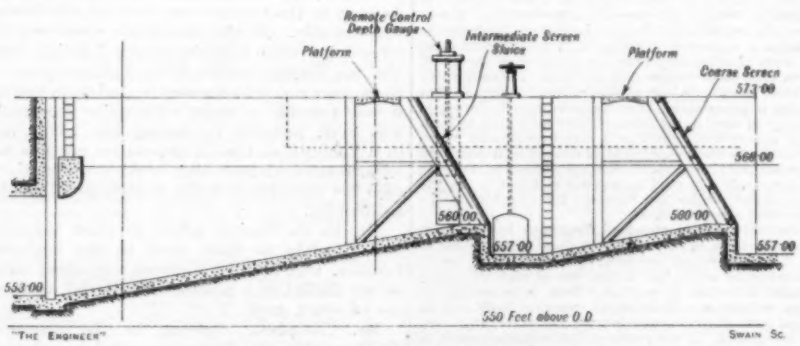


FIG. 2—INTAKE SCREENS AT BONNINGTON

Immediately adjacent to the tilting weirs and adjoining the right-hand river bank is a hand-operated sluice gate, 12ft. wide, the top of which, when lowered, is at an elevation of 566ft. O.D., and the bottom at an elevation of 557ft. O.D. The drawing, Fig. 7, shows the general arrangement of one complete opening of the Stonebyres tilting weir, which, with the difference already mentioned, is very similar to the weir at Bonnington. The water level maintained in the intake at Stonebyres is at an elevation of 299ft. O.D., and during flood water the weir will automatically lower to sill level, i.e., 291ft. O.D.

Perhaps a few constructional details of these tilting weirs, which were made by Ransomes and Rapier,

of Ipswich, to the order of the English Electric Company, may prove of interest. The gates are made entirely of steel, and at the toe the skin plate is curved to a radius of about 4½in., and fitted with tool steel knife-edge pivots, in order to reduce friction. These work on cast steel bearings, carried by the cast iron sill. The plate girder at the top of the gate is braced to the skin plate by a series of frames taking the load directly to the pivots, and it is arranged to avoid obstructing the flow of the water over the gate when it is in its highest positions. Horizontal angle members stiffen the skin locally between the vertical frames, whilst at the extreme side edges there are vertical plate members into which the main girder is built, and these plate members also carry the pins for the suspension lines. Staunching at the sill is effected by a chrome leather strip, which presses on the rounded toe of the skin plate, whilst at the sides of the plate extruded bronze bars make the seal with the sides of the piers that are finished to suit. The Stonebyres piers, which are 4ft. wide at water level, are extended upwards to carry the supporting brackets for the rope wheels, which are provided with roller bearings. The counterweights are in the form of steel boxes filled with ballast and fitted with concrete covers, and when the gate is in the normal retention position the counterbalance rests on supports on the piers, thus preventing further upward movement of the gate. The gates and counterbalance at Stonebyres are supported by steel wire ropes at each end. The gate ropes are carried in grooves on the rope wheels at a constant radius, whereas the counterbalance ropes are taken round a series of separate fusee blocks to enable the arm on which the counterbalance acts to be adjusted at the outset to suit the varying water loads on the gate in its different positions. To keep the gate ropes clear of the water, suspension bars are fitted between the gate and the ropes. These bars work in recesses in the sides of the piers, and are overhung from the ends of the gate, so as to avoid obstructing the free passage of water and floating *débris*.

FIG. 3—SURGE TANK AT STONEBYRES

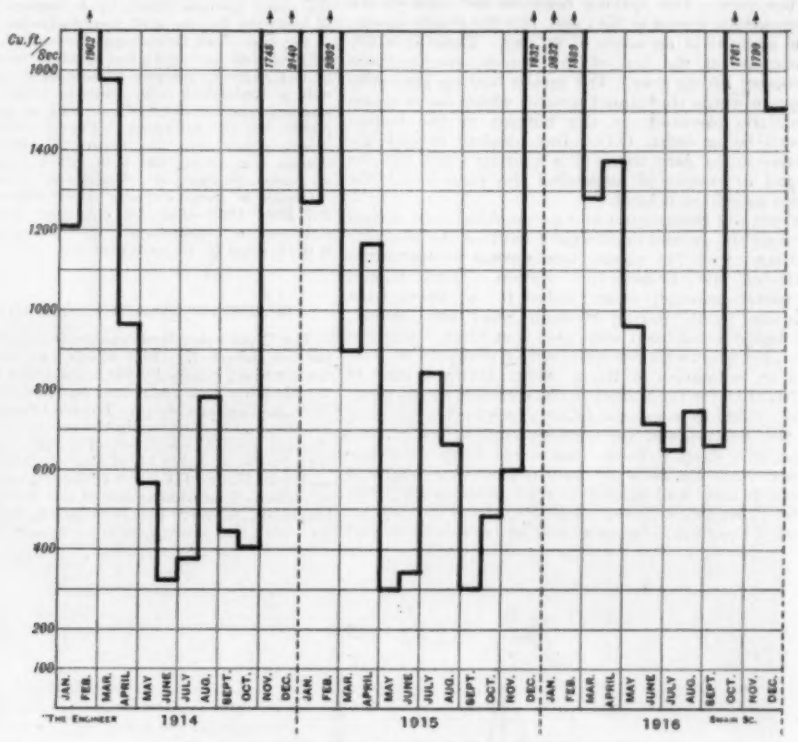


FIG. 4—MONTHLY RECORD OF FLOW OF RIVER CLYDE

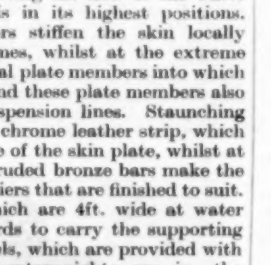


FIG. 5—BONNINGTON WEIR

The Bonnington intake works begin with a smooth concrete slab, 3½ft. wide, at the up-stream side of the intake, opening out to 14ft. at the end adjacent to the flush gate. Immediately adjacent to this slab is the intake sill supporting the first or rough screen, and this sill is at an elevation of 560ft. O.D. The intake itself is 50ft. wide, and it has a rough screen with a spacing of 4in. between bars. This screen, as shown in Fig. 2, is inclined at an angle of 60 deg., and there is a footbridge at the top, 4ft. wide. The screen is divided into sections, each of which can be independently raised. Immediately behind this rough screen the bottom of the intake is inclined, so as to form an efficient trap, bringing the bottom of the intake down to 557ft. O.D. and stepping it up again to an elevation of 560ft. O.D., thus forming a sill for the intermediate screen. This recess or trap can be scoured clean by

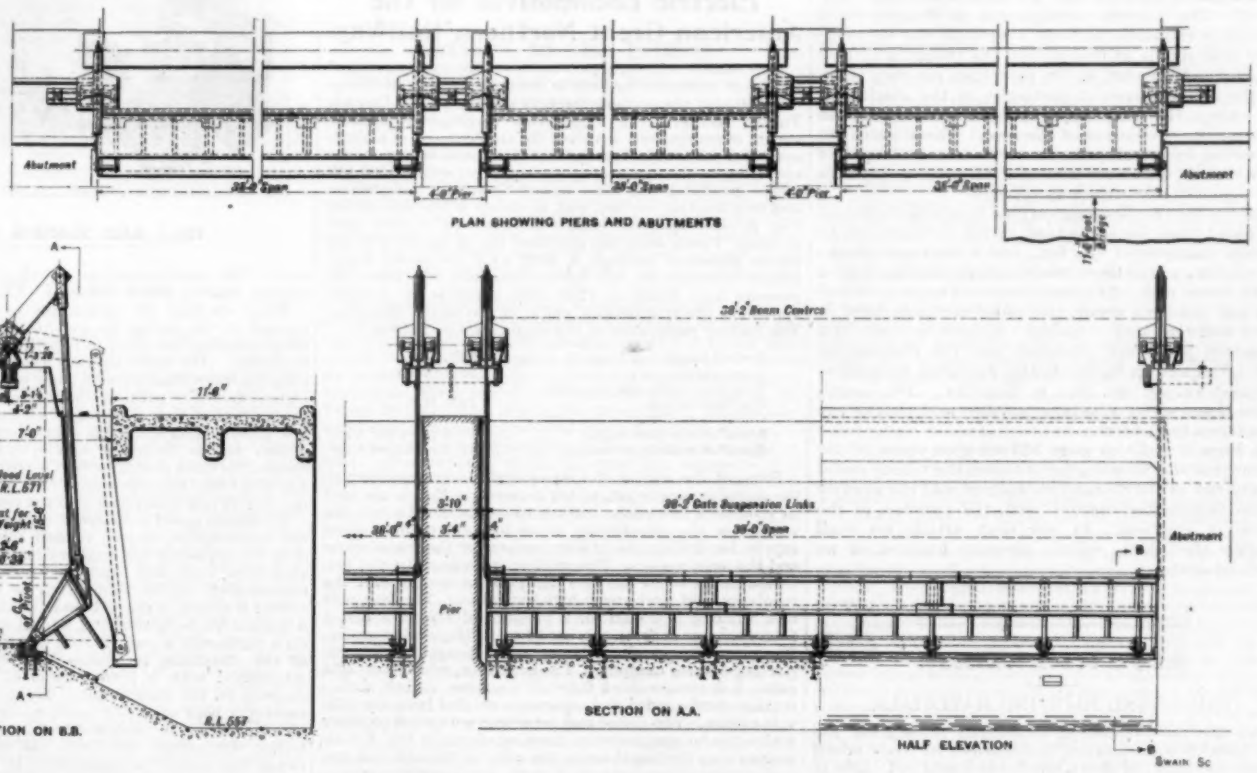


FIG. 6—AUTOMATIC TILTING WEIRS AT BONNINGTON

opening hand-operated sluice gates, which permit water to flow from the upstream side of the intake through a channel measuring 4ft. by 3ft., and discharge the silt and other deposited material through another channel discharging on the downstream side of the weir. The spacing between the bars of the intermediate screen is 3in., and, like the rough screen, it is inclined at an angle of 60 deg. There is a 4ft. footbridge at the top of this screen, carrying the necessary lifting gear. The intake bottom gradually slopes towards the tunnel mouth, which has a sluice gate, the elevation at the bottom of the tunnel mouth being 553ft. O.D. Immediately behind the intake sluice gate there is a visiting shaft for the tunnel to permit of inspecting the tunnel and the sluice gate from behind.

From the Bonnington weir a tunnel has been driven through the ground on the right bank of the river for a distance of 781 yards, terminating in the surge tank of the Bonnington station. This tunnel is partly through rock, where it is lined with concrete, and partly through sand and gravel, the latter being lined with cast iron rings, which, in turn, are lined with concrete, with a diameter of 10ft. and an inclination of 1ft. in 385ft., giving a level of 547ft. O.D. for the tunnel at the entrance to the surge tank. This is composed of reinforced concrete sunk in the ground, and its inside diameter is 57ft. and over 40ft. deep. Inside the surge tank is a fine screen with 2in. between bars placed at an angle of about 70 deg., and resting on a sill at elevation 549ft. O.D. This sill, which is raised 4ft. above the bottom level of the tank, acts as a sand and *débris* tank, and by means of hand-operated flush gates, it may be scoured out, the silt and *débris* being discharged to the river through a specially constructed channel. The connection of each pipe line with the surge tank is in the form of a bell mouth. Each pipe line is controlled by a sluice gate and emergency trip gear with electric control is provided, so that in the event of accident to the pipe line the water is automatically cut off. The general arrangement at Stonebyres is practically the same as that described, but as more water is available at this station the tunnel is 11ft. in diameter. Moreover, as the pipe lines are very short and the turbines are not protected in the station by stop valves, the sluice gates at the forebay are relied upon for the protection of the sets. These gates are controlled by an oil pressure servo-motor, the power for which is obtained from the oil pressure system that operates the turbine governors.

Each of the two Bonnington pipe lines which conduct the water from the surge tank to the turbines has an internal diameter of 6ft. 6in., and a minimum thickness of $\frac{7}{8}$in., where they join the surge tank and $\frac{9}{16}$in. at the lower end. At points where changes in direction and gradient occur, the pipes are embedded in heavy concrete anchor blocks. Inspection doors and expansion joints are provided, and the Bonnington lines terminate in hydraulically operated cylindrical balanced valves, 6ft. 6in. in diameter. The length of the Bonnington pipe lines is 800ft. and that of the Stonebyres lines 115ft.

In Figs. 8 to 13 on page 370 we give views of the Stonebyres and Bonnington stations, the tilting weirs, the interior of the Stonebyres station, and the interior of the Bonnington station, with the turbines in the course of erection. In our next article we shall describe the plant, which presents features of no small interest.

(To be continued.)

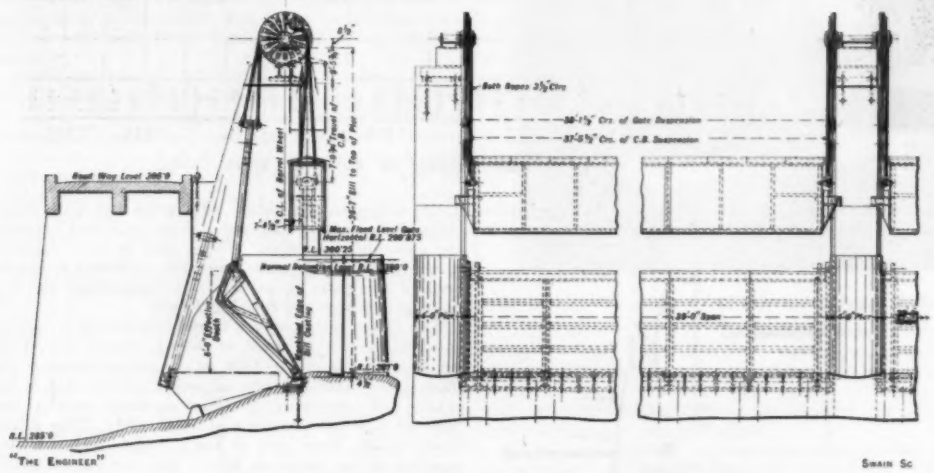


FIG. 7—AUTOMATIC TILTING WEIR AT STONEBYRES

B.E.S.A. SPECIFICATIONS.

PAINTS AND PAINTING MATERIALS.

THE British Engineering Standards Association has just issued British standard specifications for ready-mixed linseed oil paint (oil gloss), green, black and red oxide of iron, lithopone oil paste for paints, red oxide of iron oil paste (Class 1, natural or mixed oxides) for paints and (Class 2, oxide of iron base) for paints. They contain clauses regulating the composition, standard reception tests, for the purchase of these materials, and appendices giving methods of carrying out the tests. These specifications have been prepared at the request of the paint manufacturers by a committee representative of both the buying and manufacturing interests, and as in the case of all British standard specifications, they will be reviewed as experience of their working or progress in the industry renders it necessary, and revised issues will be published from time to time. Amongst other specifications in hand which will be published as completed are the following:—Purple oxides of iron, paste driers, Japan gold size, ochre, ultramarine blue, umber, sienna, non-setting red lead, black oxide of iron, black oil pastes, Indian reds, Brunswick or chrome greens.

Copies of these six new specifications—Nos. 293–295, 297–299, 1927—can be obtained from the B.E.S.A. publications department, 28, Victoria-street, London, S.W. 1, price 2s. 2d. each post free.

TUNGSTEN FILAMENT ELECTRIC LAMPS.

The British standard specification for tungsten filament electric lamps, No. 161, which was issued in 1924, has been revised chiefly by the addition of four schedules for traction, vacuum train lighting, gas-filled train lighting, and gas-filled bus lamps. The modifications made are not numerous, the chief one in the general clauses of the specification being the addition of a switching on and off test. The figures in Table II. of the schedules for vacuum and in Tables II. and III. for gas-filled lamps have been slightly modified. The dimensions of the bayonet cap, given in Appendix II., have also been modified to bring them into line with the dimensions recently adopted by the International Electro-technical Commission. Copies of this specification No. 161, 1925, can be obtained from the B.E.S.A. publications department, 28, Victoria-street, London, S.W. 1, price 2s. 3d. post free.

Electric Locomotives for the American Great Northern Railway.

OUR readers will perhaps remember that some time ago* the Great Northern Railway of America decided to change its 6600-volt three-phase traction system on the Cascade Tunnel section to a 11,000-volt single-phase system, which, of course, only involves the employment of a single overhead wire. The locomotives that have been put into operation on the new system are equipped with a 1500 kW motor generator set, three motor blowers, a compressor, and four traction motors, and, as shown in the illustration Fig. 3, each complete engine is composed of two units or cabs. Power from the overhead line is supplied to the motor generator through a 2000 kVA air-cooled transformer mounted on the locomotive, and it reduces the pressure from 10,500 to 1240 volts, which is the pressure applied to the synchronous motor of the motor generator. The leading particulars of the engines are as follows:—

Overall length	94ft. 4in.
Total weight	357·5 tons
Weight on eight driving axles	275 tons
One hour rating	4330 H.P.
Continuous rating	3660 H.P.
Speed at one hour rating	14·4 miles per hour
Speed at continuous rating	15·5 miles per hour

Some of the coils of the lap-wound motor belonging to the motor generator set, which is shown in Fig. 1, are used to provide a two-phase voltage to combine with half the voltage of the transformer so as to form a three-phase supply for driving the blower motors for the transformer and the main motors. The winding is designed to give low reactance so as to increase the pull-out torque and the revolving field works with high excitation. The four-pole field winding is wound for a pressure of 125 volts and a field discharge resistance is used for starting and stopping. The rotor also carries a heavy squirrel-cage winding for starting and for damping. The generator, which has eight poles, is a compensated 600-volt machine, slightly differentially compounded and separately excited from the 125-volt exciter. The motor and generator are bolted together with a fan housing between them, as shown in Fig. 1. Air is drawn by the fan through the sides of the cab and into the bearing end of each machine, and it exhausts through the roof and floor of the cab. The end housings carry the exciter frames without additional bearings. A 75 kW, 125-volt, six-pole, flat compounded exciter provides the current for the synchronous motor field, generator shunt field, regeneration exciter field, compressor motor, lights, control circuits and the current for battery charging. The regeneration exciter is a 25 kW, 10-volt, eight-pole machine, which serves separately to excite the main traction motors when motoring or regenerating.

The traction motors—see Fig. 2—are six-pole, 600-volt, 750-ampère, 540 H.P. motors, designed for a speed of 460 revolutions per minute when working with a full field. They are ventilated on the forced system. The air enters the machines above the commutators and it passes between the feed coils, through the air gap, through holes in the armature core, and out at the rear end through the frame and housing. The armatures are lap wound and well equalised, and the main poles and interpoles are wound with heavy copper strap. The motors are flexibly geared to the driving axles at each end, the ratio being 18 to 91. The compressor motor, which is rated at 35 H.P., and which is designed for a pressure of 125 volts, drives

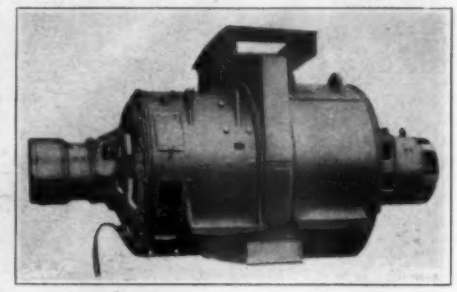


FIG. 1—MOTOR-GENERATOR

a compressor with a capacity of 150 cubic feet per minute at a pressure of 135 lb. per square inch. The blowers are driven by 660-volt, three-phase, four-pole, 10 H.P. induction motors. One of these motors is used for the ventilation of the transformers and regeneration exciter and one for each pair of driving motors.

The synchronous motor of the motor generator is started by connecting the 125-volt storage battery to the main generator through a resistance which is afterwards cut out of circuit and the field of the machine is weakened sufficiently to make it run at about one-third of its normal speed. The motor is then connected to a tapping on the transformer that gives 75 per cent. of the normal voltage when the battery is disconnected. The motor then runs up to speed as an induction machine, and when the speed is about 80 per cent. of the normal value a weak direct current is applied to the rotor, which pulls into synchronism. A reactance is then automatically connected across the 25 per cent. voltage section of the transformer and the 75 per cent. voltage tapping is disconnected. The reactance is then short circuited, thus applying the full transformer voltage to the motor with very little disturbance. The synchronous motor then runs light with a slightly leading power factor.

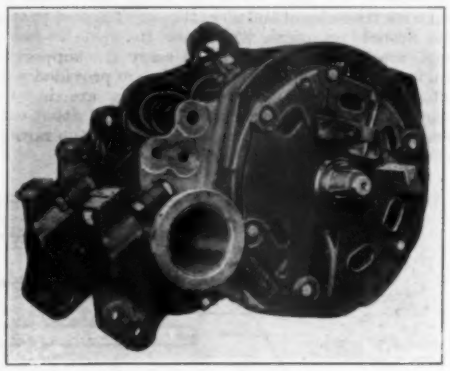


FIG. 2—MAIN TRACTION MOTOR

When starting the locomotive a higher excitation is applied to the motor by moving the controller handle, which also has the effect of reducing the excitation of the generator. The main motors, which are all connected in parallel, therefore start with a low voltage without employing resistances or without changing connections. With the proper current they will exert their full tractive effort at a low power input and with a low demand from the line whilst, as the controller handle is advanced for higher speeds, the main generator field is strengthened by cutting out shunt field resistance until full voltage is reached, when the motors run with series characteristics.

If a higher speed is desired it is only necessary to balance the regeneration exciter voltage against the series field drop by adjusting the regeneration controller or separate excitation controller with the armature circuit of the regeneration exciter connnected as in Fig. 4, and with switch B closed, A opened, and switches C opened. When a balance has been obtained, as indicated by a zero reading on a voltmeter, a push button is operated, thus throwing in the stabilising resistance and separate excitation is established with a 1 to 1 ratio of field and armature currents on the main motors. By moving the regneration controller backwards the main motor fields are weakened and higher speeds obtained, whilst advancing this controller strengthens the fields and reduces the speed or causes the motors to regenerate. If the field of the main generator is reduced when it is motoring, regeneration is

* See THE ENGINEER, January 28th, 1927.

GREAT NORTHERN RAILWAY OF AMERICA — SINGLE-PHASE ELECTRIC LOCOMOTIVE

BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA, AND THE WESTINGHOUSE ELECTRIC AND MFG. CO., PITTSBURG, ENGINEERS

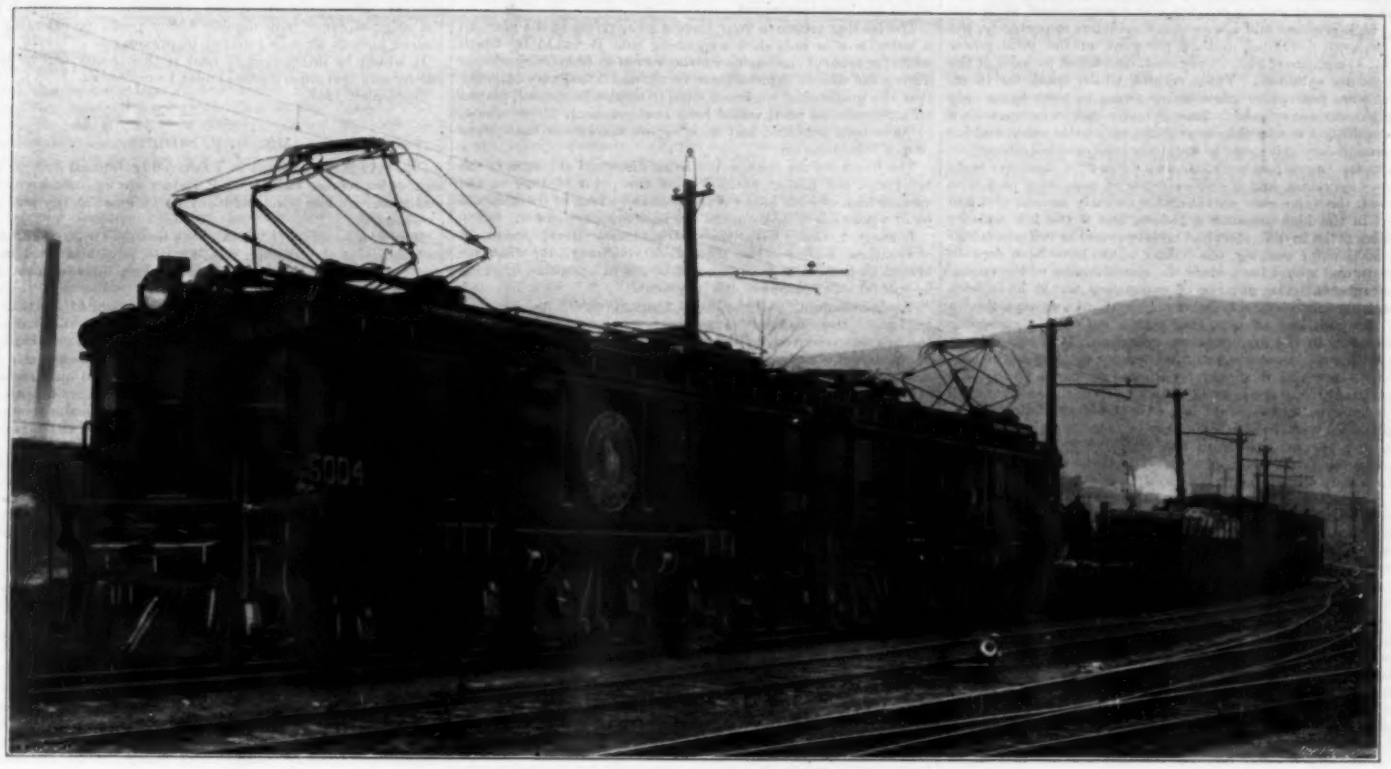


FIG. 3—3660 HORSE-POWER SINGLE-PHASE LOCOMOTIVE

increased and, practically speaking, the train can be stopped by regeneration. The scheme gives a control system of great flexibility and enables the engine driver to operate the locomotive at constant output under a wide variety of conditions. In the event of the synchronous motor being overloaded a current relay applies extra excitation to the motor and reduces the generator voltage, and warning is given to the driver. If the motor generator set is pulled out of step it immediately drops its load and it automatically pulls into synchronism ready for reloading.

The locomotives have the advantage of working with direct current series motors, which produce a good starting effort without the introduction of resistance losses; they have the constant-speed characteristics of the split-phase

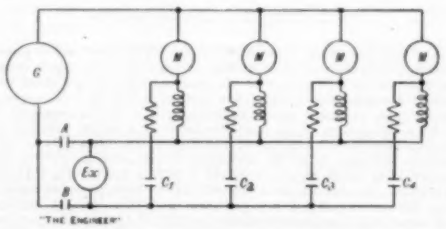


FIG. 4—MOTOR CONNECTIONS

locomotive, but the speed can be changed at will over a wide range both when the motors are drawing current and when they are regenerating; they also have the desirable advantage of working with high-voltage current drawn from a single overhead line fed from transformer sub-stations and the energy drawn from the line at a high power factor.

SIXTY YEARS AGO.

WE have grown so accustomed to the practice of having most of our warships built in private yards, that it is difficult to realise that only sixty years ago that practice was sufficiently novel to excite public interest and parliamentary criticism. From our issue of September 27th, 1867, we learn that since November, 1855—the date, presumably, of the completion of the Erebus and Terror, our first contract-built ironclad floating batteries—until the time of writing, sixteen ships of war had been built in private yards. The practice thus established marked "a new era in the history of the British Navy," for since the reign of Queen Anne the Government dockyards had been responsible for the designing, building and repairing of our naval vessels. The knowledge of how to construct a man-of-war was largely confined, or supposed to be, within the Government sheds over which marines kept guard, and within which the labour was frequently supplied by convicts from the hulks. What, we asked, would the Government surveyors and master shipwrights of old have said could they have witnessed the construction of men-of-war in yards formerly devoted to the building of Indiamen and whalers? But the times were changing. With the introduction, first, of ironclad wooden batteries, and then of the iron-plated sea-going vessel Warrior and her sisters, the Admiralty found it necessary to enlist the services of private builders, who already had had experience in the application of iron in the construction of mercantile ships. It would appear, however, that the private yards when they took up naval shipbuilding found it difficult to fix their contract prices. Out of the sixteen contract-built vessels, only one, according to a parliamentary return which we quoted—namely, the Thunderbolt—had been built without the contractors calling for payment considerably in excess of the contract price. The case of the Warrior seems to have been typical. Her hull was contracted for at £31 10s. per ton, giving a total price of £190,225. The amount actually paid was £255,582, which included a sum of £41,420 to reimburse the contractor for his costs and to allow him a profit of £12,000. Messrs. Napier, when they contracted for the Black Prince at £37 5s. per ton, under-estimated their financial requirements by £14,000. The Defence at £43 per ton did not pay Messrs. Palmer, who were awarded compensation to the extent of £15,493. Messrs. Westwood and Baillie contracted to build the Resistance at £44 per ton, but had to be given an additional sum of £10,395. The Hector, contracted for at £42 10s. per ton by Messrs. Napier, involved a compensatory payment to her builders of £34,535. The Valiant was contracted for at £51 per ton, but even at that figure her builders, the Thames Ironworks, had to seek additional payment to the extent of £19,642.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

RECENT BRITISH LOCOMOTIVES.

SIR,—Your correspondent, Mr. C. M. Keiller—THE ENGINEER, September 9th, page 279—goes somewhat astray when he asserts in his letter that "protagonists of the compound really refuse to discuss the matter at all, and boldly claim that compounding will give an increase in power of 50 per cent. or more under every condition whatsoever, and that it has not a fault in the world."

The question has in fact been discussed over and over again, but the chief difficulty that present-day advocates of compounding have to encounter is the puzzling character of British locomotive practice. The London, Midland and Scottish Railway, for instance, have now no less than 235 three-cylinder 4–4–0 compounds (about fifty of which have been completed by the Vulcan Foundry, Ltd., during the present year), yet the very latest express engines on this line are triple-cylinder simples, in this case of the 4–6–0 notation, with a working pressure of 250 lb. per square inch. Of this new type, fifty engines are, it is said, to be built by the North British Locomotive Company, Ltd.

On the one hand, therefore, the inference would appear to be permissible that compounding is found to be successful in, at any rate, the L.M. and S. Railway, if one may judge the matter by the large number of compound locomotives in use on that railway. On the other hand, such being the case, one is naturally mystified as to why the newest L.M. and S.R. express engines are of the simple expansion description, especially as these engines have 250 lb. pressure. Matters are further complicated by the fact that the three 4–4–2 French de Glehn compounds (1903–5) have failed to satisfy the Great Western authorities that they were superior to their own simples, although, in this connection, it is only fair to the French engines to point out that there have not been for many years any Great Western-built 4–4–2 engines with which to compare them. I believe that only one of the de Glehn compounds is now in service, but the Great Western people might have done worse than to try a six-coupled compound against one of their four-cylinder 4–6–0's. This course could even now be adopted in the case of one of the new "King" class, which works at 250 lb., the pressure now also employed in the L.M. and S.R.

We thus have a very contradictory state of affairs, newly constructed three-cylinder compounds being ostensibly superseded on their own system by single expansion engines. Is this proof that compounding is necessarily a failure? I do not think so. In my opinion, locomotive compounding in this country has been made unpopular chiefly owing to errors committed in both design and operation. Take, for example, the L.M. and S.R. three-cylinder 4–4–0 engines. Although admitting that these compounds are, within the limits of their design, comparatively efficient locomotives, the writer considers that a serious error was committed in the making use of a single high-pressure cylinder for present-day traffic. The three-crank system (when using only one high-pressure cylinder) not only requires the conversion of the engine to simple for starting purposes, but it also has the effect of reducing the number of expansions by half, it being necessary to employ a cut-off of 50 per cent. in the one inside cylinder, as against 25 per cent. were two high-pressure cylinders used. The retention of the two inside cylinders of an ordinary locomotive as high-pressure cylinders (say, 19in. in diameter) would have ensured ample starting power at all times; then the addition of another pair of cylinders (say, 22in. or 22½in. in diameter), placed outside the frames to form a compound engine, would have allowed of an early cut-off being used in the high-pressure cylinders, thus providing a greatly enhanced range of expansion, also a higher thermal efficiency, together with a substantial increase in power—advantages which are obviously of no little importance. The practical value of such a design will be manifest when it is understood that this modified compound could develop its maximum tractive effort (that is, up to the limit of its adhesive factor) without the cut-off exceeding 20–25 per cent. in each of the two high-pressure cylinders. In order to obtain the best results it would be essential, however, to operate the valves of the low-pressure cylinders permanently in full gear, and this could best be done by means of loose eccentrics (balanced). Hence only two sets of gear, those for driving the high-pressure valves direct would be required. The foregoing proposed design is not altogether an imaginary one, an engine having approximately the above-mentioned cylinder capacity having been actually built, and proved itself to be fully capable, up to the limit of its adhesive weight, of hauling trains up gradients of 1 in 50 with 20 per cent. cut-off. It is, of course, impracticable to run a simple locomotive at express speed with a 75 per cent. cut-off; in other words, its potential power has, for economical and other well-known reasons, to be always more or less suppressed, whereas a compound engine, designed on the lines suggested, could develop its maximum tractive power at all times. Moreover, this power, which would be available for hauling heavy loads, or for the attainment of higher speeds, would be produced in a much more economical manner than is possible in the case of the single expansion type. But it would be imperative not to limit the expansion of the steam in the low-pressure cylinders. It was fully demonstrated in practice, in the case of the actual compound already referred to, that any attempt to link up the low-pressure valves at once caused a marked reduction in speed and therefore in power.

Another case in point, as showing the grave disadvantages attending the use of only one high-pressure cylinder, in that of the Baldwin experimental three-cylinder 4–10–2 compound No. 60,000, the cut-off in the middle or high-pressure cylinder having to be relatively late, and that in the two outside low-pressure cylinders correspondingly early. Tests carried out on the Pennsylvania Railroad Company's fixed plant at Altoona showed that at 80 r.p.m. (equivalent to a rail speed of 15 m.p.h.) and for all points of the cut-off, the high-pressure cylinder developed slightly more power than did each of the low-pressure cylinders, but that at 120 r.p.m. (equal to 22·5 m.p.h.) the opposite result took place, the middle cylinder furnishing rather less power than either of the other cylinders. That is to say, as the speed increased the work done by the high-pressure cylinder fell off rapidly, the difference augmenting as the cut-off was

shortened in the low-pressure cylinders. At 200 r.p.m. (equals 37·5 m.p.h) and with a percentage of cut-off of 60 in the high-pressure cylinder and of 30 in the low-pressure cylinders, the work done by the former was about one-tenth, or, roughly, only 5 per cent. of that accomplished by each of the other cylinders at the same speed (200 r.p.m.), but with a later cut-off 80/50 per cent., high-pressure and low-pressure cylinders respectively, the high-pressure developed but 24 per cent. of the total power output, as compared with 38 per cent. developed by each of the low-pressure cylinders. These results, which speak for themselves, were practically unavoidable owing to their being only one high-pressure cylinder. That cylinder had to be run with a late cut-off, yet it was able to perform very little work, and for all the use it served it might as well have been omitted altogether. If, now, the engine had been fitted with two 20in. diameter high-pressure cylinders, and if the sequence of expansion had been reversed, the valve gear providing for an early instead of a late cut-off in the high-pressure cylinders, and if the low-pressure cylinders (27in. in diameter) had been operated in full gear under all conditions of working, the results would have been entirely different, and would have made the compounding of the engine a real success. The number of expansions would have been appreciably increased, simultaneously with an augmentation in draw-bar pull, and all this, too, with a cut-off not exceeding 25 per cent. in the high-pressure cylinders. It is self-evident that cutting off the steam early in the very cylinders—the low-pressure—in which it should be allowed to expand fully and unrestrictedly from the point of admission from the receiver until final exhaust took place could only have the effect of diminishing the potential tractive effort, not only of those cylinders, but, by hampering the exhaust from the high-pressure cylinder, the power of the latter cylinder also. The three cylinders of the Baldwin 4–10–2 compound, it should be noted, are all 27in. by 32in., the coupled wheels are 5ft. 3½in. in diameter, and the boiler pressure is 350 lb. per square inch. The fire-box, which has a grate area of 82·5 square feet, is of the water-tube type. Including that of the superheater, the total heating surface amounts to 6549 square feet.

To-day there are British locomotives (at present in limited numbers) working at 250 lb. per square inch, and I submit that if the economic advantages of that pressure are to be adequately realised compounding is essential. But not on the three-cylinder system. Four cylinders should be employed, and to enable the expansion to be complete the low-pressure cylinders, which, after all, are in reality the "expansion cylinders," should invariably be run in full gear, loose excentrics—balanced—being provided for this purpose. The design which I have outlined would, I am convinced, result in a large increase in tractive power, in reduced steam and coal consumption, and in a higher standard of all-round efficiency.

I can only echo the timely suggestion contained in your admirable leader of August 12th, that it would be very interesting and probably instructive if one of the new ten-wheelers (L.M. and S.R.) were built as a compound and its working results compared with the simples.

The Great Western, too, might usefully construct a 4–6–0 compound for trial purposes, the pressure used in both cases to be 250 lb. per square inch. I would submit further that both engines have four cylinders.

When Mr. Keiller says that all our locomotive engineers would not throw away the advantages of compounding for a mere fad, he means, of course, that if compounding were really profitable, British chief mechanical engineers generally would adopt it, but surely the converse is equally applicable in the case of continental locomotive engineers, namely, that if compounding were the failure that your correspondent implies it to be, then the last-mentioned gentlemen would cease to employ it?

Brockley, S.E. 4. JOHN RIEKIE.

September 23rd.

SIR,—I hope other of your readers than Mr. Keiller do not put me down as a "protagonist of the compound." I merely mentioned that incident to emphasise my contention that it is practically impossible for an outsider to get any invention tested by our railway engineers. Many of the questions which he says are evaded will probably be only those which are asked with the sole idea of picking the inventor's brains. As Mr. Keiller is sorry there is no up-to-date compound in this country, the idea or invention must surely have been turned down without an adequate trial.

I am quite aware that there are even larger locomotives abroad, some of which appear to be a veritable "box of tricks," but in spite of this, I still boldly maintain that the building of these unnecessary monsters in this country is a gross waste of the stockholders' money.

Mr. Keiller—and others who have written me direct—ignores the paragraph in my letter you kindly published, referring to the challenge I sent to the president of the London, Midland and Scottish and the chairman of the Great Western. Business men, to whom I have shown the correspondence relating thereto, are simply amazed that it was not jumped at. As they rightly point out, the companies stood to lose nothing, bar their experts' reputations, when we prove, as we still shall do by private enterprise, that their giants are an unnecessary waste of stockholders' capital.

While thanking you for past favours, I do not propose to trespass any further on your valuable space until I have the pleasure of advising you of the actual tests or their results.

E. P. AINSWORTH.

Harrogate, September 26th.

SIR,—Mr. Keiller, in discussing four-cylinder compound engines of the French type, points out that some of them are considerably larger than modern British locomotives, in which an axle load as high as 22½ tons is permitted, and, in particular, he refers to the new Spanish "Mountain" type engines as "colossal." But what would he himself have done if called upon to provide an economical engine to haul heavy trains, at a good speed over a mountainous road in any extreme of climate, subject to the condition that on no account must the weight on any one axle be allowed to exceed 16 tons? Obviously, in such circumstances anything resembling a modern British engine would be quite impossible.

In fact, the designer and builder of these splendid Spanish engines—would that he had been an Englishman!—told me of the meticulous care required to keep within the weight restrictions; and the result is one upon which he may fairly be congratulated. Incidentally, it is also another triumph for the French compound system.

W. B. THOMPSON.

London, S.W. 1, September 26th.

MECHANICAL ENGINEERING IN THE ARMY.

SIR,—As an engineer who served as a workshops officer with the mechanical transport through the war, I have naturally been deeply interested in the change in the War Office administration which has been announced.

The leading article in your current issue refers to the matter; a letter is also published suggesting that it would be worth while for some of the engineers who served as temporary officers during the war to express their views, and I feel very strongly that the mechanical engineers who, it cannot be denied, played an all-important part, would have enabled much better results to have been achieved had their expert knowledge been given proper consideration.

The results of the changes are being discussed at length in the lay Press, but almost entirely from the point of view of the various high officials in the War Office and which of them should be in a position to make use of the mechanical engineer.

I suggest that, with the extraordinary development in mechanised warfare, the mechanical engineer, to whatever branch he nominally belongs, must be put in a position in which he will be able to exercise his judgment.

There is no doubt that the Royal Army Service Corps' administration of the mechanical transport was successful, but the success was achieved by the engineers with expert knowledge about motor vehicles who joined the Corps during the war and held practically all the key positions.

I am not suggesting that the regular Army officers who have had engineering training did not play their part, but there were so few of them who had any knowledge of mechanical transport.

In the Navy the same thing occurred. The engineer from the mercantile marine joined the Royal Navy and the war could not have been won without him. The reactionary element after the war immediately did their utmost to put the engineer in an inferior position, fearing that he was becoming too powerful.

I hope, Sir, that you will continue to uphold the position of the engineer in the Army in the way that you have already done for the Navy. WORKSHOPS OFFICER.

September 27th.

SIR,—I am impelled to endeavour to correct some misapprehensions which I think have inspired your leading article, "Mechanical Engineering in the Army."

The state of affairs prior to the recent decision was this: three Corps, the R.E., R.A.S.C., and R.A.O.C., each dealt with part of the mechanical vehicles of the Army. This was obviously unsound, and failing the establishment of a new Corps, undesirable for many reasons, one of the three Corps must take over that part of the work hitherto performed by the other two.

Your leader maintains that the R.A.S.C. should do this; but why? You admit that the R.A.S.C. is not an engineering Corps, while, pace your leader, both the others are, and are both well versed in dealing with civilian firms.

I cannot agree, either, that the running of tanks and dragons is so specialised as to call for "a different class of experience." All types of vehicles must travel across country, they all have similar power units and transmission systems. The reasons for electing the R.A.O.C. in preference to the R.E. for this work are not cogent to your leader, nor do I know them. As a matter of historical interest the (then) A.S.C. took over mechanical transport from the R.E. during the South African War. R.E.

September 27th.

INLAND NAVIGATION ABROAD.

SIR,—We have read with much interest your illuminating article in the issue of August 26th, regarding the position of canals in this country. In this article you say "it is not worth while to discuss at length the reasons responsible for the decline of the English canal system."

There is no doubt that one of the reasons for the decline of canals in this country has been the maintenance in a large number of canals of the antiquated system of horse-haulage. This method of haulage is not only slow but very expensive, particularly in the case of barges carrying small unit loads. We believe that a number of canals in this country could be restored to usefulness if mechanical traction for the barges were substituted for the existing horse-haulage.

It is quite a simple arrangement to provide for haulage by wire ropes suspended on standards running along each side of the canal. These hauling ropes would be made to follow the turnings and twistings of the canal, under bridges, and pass all obstructions that might occur on either bank as required.

The barges would be attached by tow ropes to these hauling ropes in such a manner that the steersman of the barge has complete control over the speed from the full speed of the hauling rope, say, 6 to 8 miles per hour, down to absolute zero, and any required reduction of speed when passing through locks, &c., could be automatically arranged.

With such a system only one man per barge would be required, whilst the barge was travelling. The rate of speed would be at least treble that of existing horse-haulage, whilst the cost would be about one-third that of the present cost, and efficiency would be almost the same for a large load or a light load or barge, whilst the cost of actual installation of such hauling ropes, say in 10-mile sections, with automatic passage from one section to the other, would be relatively very small.

R. WHITE AND SONS.

Lancashire, September 22nd.

DERAILMENTS AND NATURAL OSCILLATION PERIODS.

SIR,—Further to Mr. Wallace's remarks in your issue of the 23rd, regarding oscillation periods of engines. Although not a railway engineer, it is a theory I have long been interested in and one which, to my surprise, I have never seen mentioned in an inquiry concerning an accident at speed.

A very good instance of what I choose to call a "cumulative oscillation" was witnessed by me in the last coach of a train during a run between Salisbury and Exeter, when, whilst travelling at a speed well in excess of 70 miles per hour, the carriage in question rolled and rocked so violently, that the impression was that derailment was imminent. Suddenly, either by striking a slight curve, or by a slight irregularity in the beat of the rail joints, the whole oscillation would be damped out, only to restart and gradually increase to a maximum.

The train was pulled by a locomotive of the "King Arthur" class, and was made up of fifteen coaches, and at the time it occurred to me again, as on previous experiences of this nature, that on main lines where high speeds are the schedule, shorter rails spaced at regular intervals to be determined by the conditions prevailing, would no doubt tend to destroy these violent and unpleasant oscillations.

A train can be said to have a mean oscillation curve, as it were, passing through its bogie centres, and if to this curve circumstances make it that the secondary oscillations of the train springing are superimposed and are additive, the result is that the original curve may assume heavy peaks representing the violent periods already referred to previously.

It would be interesting to hear if this theory can be borne out by any real experiences similar to my own? Z.

September 23rd.

MR. G. P. BIDDER.

SIR,—As you suggested in a Seven-day Journal note in your issue of September 2nd, Mr. G. P. Bidder was more than a mathematician. He was a man of many parts, great ability and very generous.

Having a home in Devonshire, he became aware of the early endeavours of the late Mr. Wm. Froude, gave him considerable assistance, and continued to take a very keen interest in Froude's work throughout the whole of his life.

A relative of the late Mr. W. Froude informed me that Mr. G. P. Bidder lent his launch to Mr. W. Froude in the year 1866, and by the experiments which followed in Dartmouth Harbour, the foundation of the model resistance experiments was laid. The models were towed from scale beams rigged out across the launch both forward and aft. The cadets of H.M.S. Britannia, seeing all these curious events going on, came to the conclusion that Mr. Froude was doing it for amusement, and the operations excited sympathy for his mental condition.

The towing results then made with models of different sizes but of similar form roughly confirmed the application of the "law of comparison" to ship and model experiments, as Mr. Froude had already propounded from mathematical reasoning. Mr. Bidder brought Froude's work to the notice of Mr., afterwards Sir Edward Reed, who was then Chief Constructor to the Navy, and convinced him of the value of these towing experiments. By Reed's influence a Government grant was obtained for establishing the experimental tank, which was built by Admiralty funds near Mr. Froude's house, Chelston Cross, at Torquay, in 1870. Froude's work from this point is well known.

Mr. G. P. Bidder collaborated with Froude and Sir Wm. Thomson (Lord Kelvin) in preparing the design of the apparatus fixed in H.M.S. Greyhound during the celebrated towing trials of that ship, whereby the law of comparison was definitely established in its application to ship and model resistance experiments.

Mr. Bidder was also an interested and useful member of the celebrated Admiralty Committee on Designs, which followed the loss of H.M.S. Captain. J. H. NARBETH.

St. Leonards-on-Sea, September 20th.

EDUCATIONAL INTELLIGENCE.

THE session 1927–28 opens at University College on Monday, October 3rd. Students of the Faculty of Engineering will be received by the Provost and the Dean between 10 a.m. and 1 p.m. on Monday and Tuesday, October 3rd and 4th. The special courses that have been arranged include one by Professor J. A. Fleming on "The General Principles of Telegraphy, Telephony, Wireless Telegraphy and Telephony, and Electrical Measurements Connected Therewith." Particulars of this and other courses, as well as of public lectures, may be had on application to the Secretary, University College, London, W.C. 1. A stamped addressed envelope should be enclosed.

A HIGH-PRESSURE POWER STATION.—The new super-power station which is to be built at Mannheim will operate at a steam pressure of 1400 lb. gauge at the boilers. There are to be two sets of Brown-Boveri plant, the first of which will comprise a 3000 r.p.m. primary steam turbine with a steam capacity of 60 to a maximum of 85 tons per hour at a gauge pressure of 1340 lb. and a temperature of 810 deg. at the stop valve. The primary turbine is to be arranged to exhaust at 270 lb. per square inch gauge pressure to the existing live steam turbines in the station, and also to a direct-coupled back-pressure extraction turbine arranged for preheating. This second turbine will have a maximum extraction capacity of 18 tons of steam per hour at 120 lb. gauge pressure, while the maximum quantity of its exhaust will be about 11 tons per hour at 50 lb. per square inch gauge. Both the primary and the back-pressure turbines will be coupled to an existing Brown-Boveri alternator of 10,000 kVA capacity, which up to the present has been used as a synchronous condenser. The second set of machinery will be generally similar to that already described, except that its steam capacity will be 50 tons up to a maximum of 70 tons of steam per hour, and it will be coupled to a three-phase 4800-kW alternator. The Mannheim station will be the first supply undertaking to operate at such a high steam pressure.

THE ASSOCIATION OF SPECIAL LIBRARIES AND INFORMATION BUREAUX.—Where to find specialised information of all kinds was the dominant note of the fourth conference of A.S.L.I.B. (the Association of Special Libraries and Information Bureaux) that was held at Trinity College, Cambridge, during the week-end, September 23rd–26th. Close on 200 attended, representing organisations of every variety, including the Empire Marketing Board, Ministry of Labour, Board of Trade, Institution of Mechanical Engineers, British Medical Association, Department of Scientific and Industrial Research, and the British Electrical and Allied Manufacturers' Association. A number of foreign organisations were represented, such as the International Institute of Intellectual Co-operation (Paris), the International Institute of Bibliography (Brussels), the International Labour Office (Geneva), the American Library Association, the Special Libraries Associations both of America and Denmark, the Dutch Institute of Documentation and the International Commission of Decimal Classification (Deventer, Holland). There were many representatives of important industrial and commercial interests. Mr. Stephen Gaselee, Sir Horace Plunkett, Sir George Fordham, and other well-known individuals also participated. Visitors were received on arrival by Sir J. J. Thomson, O.M. (Master of Trinity). After the presidential address of Sir Geoffrey Butler, K.B.E., M.P., the conference proceeded to discuss the recent report of the Public Libraries Committee appointed by the President of the Board of Education. A resolution was passed endorsing the proposal to expand the Central Library for Students into a truly national lending library, which would act as a reservoir of books for libraries throughout the country. A paper by Colonel Sir Henry Lyons, Director of the Science Museum, dealt with the important developments that are now taking place at South Kensington in what is already one of the world's greatest scientific libraries. Sectional meetings were then held. The Association has in preparation and will publish in the near future a Directory of Sources of Specialised Information, edited by Mr. G. F. Barwick, late Keeper of Printed Books at the British Museum. This book is being issued with the financial assistance of the Carnegie United Kingdom Trust.

Railway Matters.

WHEN the British Empire Exhibition at Wembley was built in 1923 the London and North-Eastern Railway built a station in the grounds, which is served by a circular loop and named Wembley Exhibition Station. It has now been re-named Wembley Stadium Station.

WITH the introduction of the winter train services on Monday last, the 10 a.m. from Euston to Glasgow and Edinburgh—the Royal Scot—runs non-stop through to Carlisle, and no longer calls at Carnforth to change engines. The distance of 299 miles is the longest such run in the world.

RECENT observations show that all the main line locomotives and all the coaching stock except some four-wheeled and six-wheeled vans on the Central, or former Brighton, section of the Southern Railway are now provided with the vacuum brake as additional to, or in substitution of, the Westinghouse. One advantage thereby reaped is that on the coast lines former South-Western stock can be freely used, which is a great acquisition when there is any demand for rolling stock.

THE Ministry of Transport inquiry into the collision on September 19th at Plaistow was held on Monday last by Lieut.-Colonel Mount. A goods train was leaving the yard and therefore the signals at Plaistow were kept at "danger," as was also the starting signal at West Ham, the signal-box in the rear. The driver of a passenger train, however, overlooked the condition of the starting signal and of the home signal at Plaistow, and allowed his train to come into collision with the goods train.

JUDGING by the *Railway Review*—the organ of the National Union of Railwaymen—the recent railway strike in Queensland has a lesson for the men here. In its issue for September 16th our contemporary observed:—It is another repetition of the "sympathetic strike," and should serve to indicate how dangerous to railwaymen it is to flirt with that theory. If it be once established that railwaymen are not to handle "black" goods, they will be involved in endless disputes; in fact, they would never be free, and would be the cat's-paw for all who liked to use them.

THE forthcoming retirement of Mr. Robert C. Irwin, the secretary to the London, Midland and Scottish Railway, is announced. Mr. Irwin has been connected with the Lancashire and Yorkshire since 1881, and when Mr. C. W. Bayley was made chief traffic manager in 1899 he became secretary. On the Lancashire and Yorkshire being amalgamated with the London and North-Western Railway, Mr. James Bishop, the secretary to the latter company, retired, and Mr. Irwin came to Euston to fill that office for the amalgamated company, and, in due course, was appointed secretary to the London, Midland and Scottish.

A PRESS Association correspondent of the *Manchester Guardian* stated recently that plans for the co-ordination of London traffic will shortly be considered by Colonel Wilfrid Ashley, of the Ministry of Transport, by the Home Counties Advisory Committee. The scheme provides, it is reported, for a London traffic pool between omnibuses, trams, and tubes, with joint management and a common fund. The principle of private ownership is retained. Competition between the omnibuses and trams is thought to be wasteful in many districts, and it is understood that restricted services of both on certain routes form the basis of the Committee's recommendations.

A CLOSER survey of the annual report by Colonel Sir John Pringle on the railway accidents of 1926 shows that the fatalities to railway servants are more remarkable than we recorded in the note in our Seven-day Journal on September 16th. The returns show that two men were so killed, and we stated that that was the lowest figure recorded since the Act of 1871 was passed. We now learn that one of the two men who were killed was the porter at Naworth, who was concerned in the motor car disaster there in August. Thus only one trainman lost his life in a train accident, and that was the unfortunate driver who took an express past the signals near Fleet and ran into a milk churn train.

THE regular supply of domestic coal in London during the coming winter would appear to have been ensured by the London and North-Eastern Railway Company, in co-operation with the London, Midland and Scottish, having appointed an officer who will keep in touch with the coal merchants and learn the amount of coal they have on hand and in transit. The official statement says that the company in recent months has had under consideration the creation of a special section to supervise the working of coal traffic to the London depôts. Certain officers have been delegated to take charge of this matter. The view of the company is that when the scheme is put into force it will help the coal merchants greatly and will also be satisfactory to the consumers.

A BOOK of much use to the trading community has just been published by the Traders' Co-ordinating Committee, the joint body formed to represent traders in the revision of railway rates and charges under the Railways Act of 1921. It will be remembered that this Act entirely remoulded all classes of traffic carried by rail, and also the rates and charges applicable to them, instituting in their place a new set of rates and charges which were to come into force as from an "Appointed day." The date of this "day" has now been fixed for January 1st, 1928, when the whole range of new classifications as well as new rates will come into force. Previously to the passing of the Railways Act, years of railway practice had resulted in a series of exceptional rates being granted for commercial reasons to various classes of traffic. As the matter now stands, traders all over the country are naturally anxious to know what is their position with regard to the exceptional rates which they have previously enjoyed. The booklet, published by the Co-ordinating Committee, is designed to give a full statement as to the position, the obscureness of which is causing traders a good deal of inconvenience and anxiety. It sets out the scheme agreed upon between the railway companies and the traders, with the undertaking given by the companies in connection therewith. Copies of the book may be obtained, price 1s. each, post free, from the secretary, Traders' Co-ordinating Committee, 39, St. James's-street, S.W. 1.

Notes and Memoranda.

THE new pumping station at Bilston, which was opened on the 28th inst., is equipped with two four-cylinder vertical oil engines by Ruston and Hornsby, of Lincoln.

THE inaugural luncheon held at the Clarence Hotel, Teddington, on the 21st inst., in connection with the Research Association of British Paint, Colour, and Varnish Manufacturers, was attended by representatives of industry, the scientific world, and Government departments, many of whom took the opportunity to inspect the laboratories in Waldegrave-road. The research station has a floor space of approximately 6000 square feet, and stands in an acre of ground. Three chemical and physical laboratories occupy the upper floor, whilst below are rooms suitable for a technical laboratory, workshop, and semi-manufacturing scale operations. The laboratories are equipped with all the necessary apparatus for the study of the properties of any material used in the trade.

ALTHOUGH there are many deposits of sandstone, only a few are suitable for the production of grindstones, according to a report on abrasives recently issued by the Canadian Department of Mines, prepared by Mr. V. L. Eardley-Wilmot. Carboniferous sandstones appear to be the most productive of the formations, as the producing quarries in the Maritime Provinces of Canada, Ohio in the United States, and the Newcastle area in England, are all carboniferous in age. Most of the Canadian stones have been quarried from the Millstone Grits of the Middle Carboniferous, and a few from the Upper or Permo-Carboniferous of the Pictou area, Nova Scotia. The thickness of the bedding as well as the closeness and uniformity of the cross jointing further determines the suitability of the sandstone. No matter how good the physical properties of the stone may be, the deposit is useless unless the beds are sufficiently thick and the joints far enough apart to ensure that large grindstones or pulpstones can be cut and dressed from the quarried blocks.

EXCLUDING machines, the electrical exports from Germany in 1926 amounted to 92,223 tons of the value of 298,197,000 marks, whereas the imports reached 2322 tons, of the value of 15,324,000 marks. The exports in the first half of 1927 were 40,202 tons of 139,762,000 marks value, the imports having been 1699 tons, valued at 8,921,000 marks. While various countries increased their imports from Germany in the first half of this year, others reduced their purchases from that source. The largest share in the exports this year has been taken by apparatus for lighting, the transmission of power, and electrolysis, the value being 36,472,000 marks; the second place is occupied by wireless apparatus of the value of 18,024,000 marks, of which 25 per cent. was sent to England. The exports of cables amounted to 17,705,000 marks, of which Holland received 26 per cent.; telephone apparatus exports were 10,855,000 marks, of which Italy absorbed 23 per cent.; while measuring apparatus and meters amounted to 15,961,000 marks, Italy taking 12 per cent.

OWING to complaints that the signals of 5 G B cannot be satisfactorily received in parts of Birmingham, the British Broadcasting Corporation's engineers recently conducted a week's test with a portable set installed in a motor van, and the Corporation has issued the following statement: "Using a seven-valve super-heterodyne receiver and a detector plate-current meter, it was established that the signal strength of 5 G B throughout the Midlands was quite equal to the strength of reception of that station in the East End of London. Given suitable receiving apparatus, the programme should be picked up with equal facility in Birmingham." Not all listeners have adapted themselves to the new conditions and their sets would appear to be not sufficiently sensitive. The British Broadcasting Corporation's engineers will, however, do their share towards improving reception of 5 G B in the Midlands, and it is hoped within the next three or four weeks to bring into operation a better aerial system involving a bigger and improved aerial with increased strength of transmission.

ACCORDING to Mr. Lind, Director of Experimentalfaeltet, the public farm on the outskirts of Stockholm used for agricultural experiments, the problem of using electricity as a source of heat in the growing of vegetables has been definitely solved. On an area of 3288 square metres on the experimental farm electric cables were laid in the ground, raising its temperature to 16 deg. Celsius at times when the heat of the sun was insufficient. Electric heating has, it is stated, yielded excellent results, especially in spring and autumn. The horticultural products were not increased in size, but their development was accelerated and they were protected against frost. Electric heating, in the opinion of Mr. Lind, will prolong the season during which vegetables can be grown to ten months in many parts of Sweden, and he foresaw the establishment of large gardens in the neighbourhood of electric power stations in Norrland, where current is very cheap. The cost of electric current has so far been the greatest obstacle to the general adoption of the system, but in many parts of the country its use has already been found profitable.

IN a paper read before the Society of Engineers, Mr. R. C. Hall deals with the lead electric accumulator in modern practice. A general description of the accumulator follows, the most important parts, such as the box, electrolyte and plates being described in detail, while the differences between the various kinds of plates are summed up and the reason for the selection of a particular strength of acid is given. The chemical action of the cell is touched upon and the necessity for great purity of materials is emphasised. The manufacture of the different parts of the cell is dealt with at some length, and particulars are given of modern practice in box making, plate casting, pasting and forming. The matters of erection, position, charging, discharging and care of batteries are discussed. Instructions are set out for the official test of a battery for the purpose of obtaining its watt and ampère-hour efficiency. The relative size of the engine and dynamo compared with the capacity of the battery is suggested, and a simple method of obtaining the necessary particulars is given. Switchboards are described and the equipment and operation of an ideal switchboard is shown.

Miscellanea.

IT is proposed to construct a viaduct, or high-level roadway across Circular Quay, Sydney.

THE Mafeking Town Council has agreed to expend £8000 on the extension of its electricity plant. A new 110 kW direct-current set is to be installed.

A CONDENSING turbine locomotive is to be tried on the Port Augusta–Kalgoorlie Railway, Australia, on account of the hardness of the water available along that line.

THE Durban Harbour Board is inviting tenders for a steam tug, 170ft. long by 34ft. 6in. beam and 16ft. 6in. draught. She is to be a sea-going vessel with twin screws.

FOR Cape Town there are required two 20-ton electrical overhead travelling wharf cranes, with spares, and three 4-ton electrically driven Portal jib cranes for the Amsterdam coal yard.

THE new deep-water quay at Albert Edward Dock, North Shields, which is being built by the River Commissioners at a cost of a quarter of a million pounds, it is hoped, will be partially opened for traffic next June, and the Norwegian mail boats now coming to Newcastle will berth there.

WORK has at last been started on the commercial production of oil by the distillation of shale at Latrobe, Tasmania. At present about 40 tons of shale are being treated a day, and a storage tank of 120,000 gallons capacity is being installed. It is hoped to erect a refining plant next year.

THE second largest mechanical excavator in Germany has been installed in the new brown coal—lignite—field at the Friedrich mine, near Trais-Horloff. The machine occupies a space of 20 m. by 12 m., and is 36·5 m. high. It travels on three caterpillar tracks, each 10 m. long. It is to start work in October.

WORK on the 60 million dollars suspension bridge, which is to extend a mile and a-half across the valley between New York City and Fort Lee, N.J., was begun on September 21st. Ground was broken on both shores for the towers which are to be 620ft. high. It is claimed that when completed in 1932 the new bridge will be the biggest of its type in the world.

SWEDEN is evincing a growing enthusiasm for wireless, an increase of 4000 in the number of licenced listeners being registered during August. According to the *Wireless World*, there are now 303,338 licences issued, which means that every twentieth Swede has his wireless set. The new high-power station at Motala is credited with having increased public interest in broadcasting.

IT is reported from Germany that following the acquisition by the United Steelworks in May of the American patent for the production of "Armco" rust-resisting iron, the company, in conjunction with the Krupp works, has now acquired the English patent for the production of rust-free steel, made according to the Hamilton-Evans open-hearth process. This steel is a chrome alloy produced by a process hitherto unknown in Germany. The chief advantage of the new process is said to be a considerable cheapening of prices.

THE third 7500-kW turbo alternator set ordered in May, 1926, for the Cape Town Corporation's electricity generating station in Dock-road was, says the *South African Engineer*, put on commercial load early in August. This set, which is designed for an economical output of 6000 kW at 0·8 power factor lagging and a continuous rated output of 7500 kW at 0·8 power factor, is a duplicate as far as possible of two other units installed in 1923 and 1926, and its installation completes the extensions of generating plant in the Dock-road power station, for which justification can be given on economic grounds.

THERE are four paint works in the Bombay Presidency. These, states the *Chemical Trade Journal and Chemical Engineer*, were started during the war, but now have to face the very severe competition of imports. The Gahagan Paint and Varnish Factory at Parel, Bombay, has the largest and best-equipped plant, and turns out paints and varnishes of various grades suitable for local requirements. The K. D. Rane Paint Works, situated at Khar-road, near Bombay, also turns out paints of various kinds for the local bazaar. The Bijapur Mahalaxmi Company has also a paint factory attached to its oil mill and manufactures good paint in small quantities. The Pioneer Paint and Oil Mills at Mullund, near Thana, has been closed down, owing to heavy losses, and other factories are also threatened with the same fate. Government, public works and railways are the largest consumers of paints and varnishes.

WORK is reported to be proceeding satisfactorily on the reconstruction of the port of Antofagasta, the principal nitrate port of Chile. Funds were obtained by a loan raised partly in England. The contract for the first part of the project, awarded to the Yugoslav firm of Barburizza, Lazaguirre y Cia., of Valparaiso, called for the construction of a long breakwater costing 68,067,900 pesos (£5,105,092). The work includes a large amount of filling-in to provide space for loading and unloading machinery, railway sidings, &c. The breakwater, 1029 m. long, is built of large blocks manufactured by the contractors and made of cement obtained from a factory in South Chile. The rock comes from a hill near the port. In building the breakwater difficulties were encountered by reason of the varying depths of water only a few yards from the shore. The bottom is a hard granite. To increase the area wherein large ships can be docked, a large amount of blasting remains to be done. The second section of the port works has been begun and will cost 90,867,328 pesos (£6,615,049). The work will include a breakwater, three piers, the deepening of the water near the shore line, and the provision of a number of warehouses, customs stations and electrical equipment. It is expected that the work will be completed by the end of 1929. The Government intends to make Antofagasta, naturally an open roadstead in the centre of Moreno Bay, well protected against north winds, but exposed to the full fury of the winds and swell from the south-west, one of the best ports on the Pacific coast of South America. The number of immense granite rocks close to the approaches of the port and the anchorage ground have always been troublesome to shipping.

HYDRO-ELECTRIC WORKS ON THE RIVER CLYDE

(*For description see page* 364)

FIG. 8—BONNINGTON STATION

FIG. 9 STONEBYRES STATION

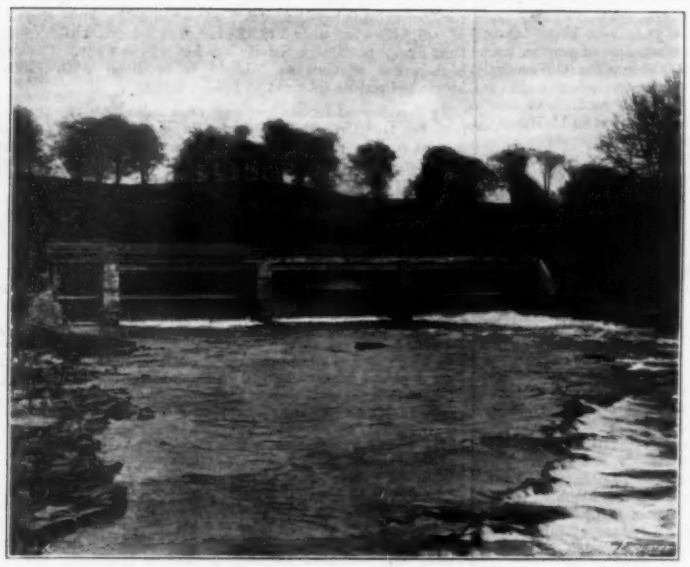


FIG. 10—DOWNSTREAM VIEW OF BONNINGTON TILTING WEIRS

FIG. 11—STONEBYRES TILTING WEIRS AND INTAKE

FIG. 12—INTERIOR OF STONEBYRES STATION

FIG. 13—TURBINES IN COURSE OF ERECTION

The Engineer

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SIXTEEN-PAGE SUPPLEMENT—"THE METALLURGIST."

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The Metallurgist

THE SEPTEMBER NUMBER OF THE MONTHLY METALLURGICAL SUPPLEMENT TO "THE ENGINEER" ACCOMPANIES THIS ISSUE.

DEATH.

On September 20th, at Bath, CAMILLO ISLER, Chairman and Managing Director of C. Isler and Co., Ltd., Bear Lane, Southwark-street, London, S.E. 1.

THE ENGINEER.

SEPTEMBER 30, 1927.

Hardness and Superhardness.

ONCE again we are indebted to Mr. E. G. Herbert for fresh inspiration in the study of that important but perplexing property of metals—their hardness. In the paper which he presented last week before the Iron and Steel Institute, and in the course of additional remarks thereto, he revealed the results of his most recent research on hardness and the practical application which he foresaw for them. Mr. Herbert has been studying the additional hardness produced in hard steel when subjected to abrasive wear. He tested old worn rails, tires, gear wheels, cams, and other articles, and found in each case that the hardness of the surface that had been subjected to wear was considerably greater than that of the original metal. This superhardness diminished gradually from the skin inwards until at a depth of one to two millimetres below the surface it shaded into the original hardness of the metal. That soft steel such as that from which rails and tires are made hardens under wear is no new fact, but that a like process takes place in articles such as gears and cams originally case-hardened or even hardened throughout is perhaps not generally recognised, although Hultgren and others have observed the effect. It would appear that the abrasive wear, if it is to cause superhardening, must be so severe as to lead to plastic flow of the metal below the abraded surface. Such plastic flow, Mr. Herbert's experiments lead him to believe, can occur even in very hard steel. In fact, the superhardening capacity of case-hardened or hardened alloy steels would seem in general actually to be greater than that of plain carbon steels. Two considerations of importance at once present themselves for discussion. Has the original hardness of a metal exposed to severe abrasion any effect on the resistance of the metal to wear? Mr. Herbert states definitely that it has not. The wear-resisting property of the worn surface is, he says in effect, determined by the superhardening capacity of the metal. In that surface there is no metal left possessing the original hardness, and therefore, he argues, the original hardness can be of no importance in relation to resistance to wear. The second consideration is of a thoroughly practical kind. Mr. Herbert has addressed himself to the problem of discovering whether articles of hard steel can be superhardened before being put into use with a view to increasing their resistance to wear. He has, we gather, been able to answer the question affirmatively, and has devised a means of bringing about the superhardening process under controlled conditions.

The practice of hardening or case-hardening portions of metal which are to be subjected to trying conditions of wear is so well established that we must naturally pause to examine closely any suggestion that that practice is not well founded or at least not properly understood. Mr. Herbert, if we follow him correctly, does not mean to imply that a hardened article is no more capable of resisting wear than an unhardened article of the same material. The implication of his results would seem to be that a hardened article resists wear better than an unhardened one, not because it is hard when it is put into service, but because its original hardness promotes the subsequent development of superhardness, the real quality on which its resistance to wear is based. It may still follow, however, that the original hardness is a factor of very great direct importance. Superhardening, depending as it does on abrasive wear and a certain plastic flow in the metal beneath its skin, cannot be an instantaneous process. The interval of time elapsing while the superhardened skin is being formed is presumably a critical period in the history of the part. If it is soft to begin with it may wear excessively before the superhardening effect has time to establish itself. If it is initially hard it will reach the superhardened condition without excessive wear. The logical deduction follows that, if we can tolerate the excessive wear experienced by the soft material before it reaches the superhardened state, we may ultimately achieve in it a resistance to wear as great as that attained by subjecting it to an initial hardening process. Mr. Herbert's researches seem to be capable of interpretation in support of this deduction. In an old, worn, tire he found in the centre of the section a hardness of 239 Brinell. On the tread he discovered a spot at which the abrasive wear had superhardened the steel to 648 Brinell. In a tooth of an old worn gear wheel which had been made of nickel-chromium steel and originally hardened throughout in oil from a temperature of 830 deg. Cent., he found in the interior an initial hardness of 485 Brinell. Abrasive wear on the surface had superhardened the steel to 657 Brinell. In their final states, therefore, the soft steel of the tire and the hardened alloy steel of the gear wheel had acquired almost exactly the same degree of superhardness. It would, of course, be quite wrong to suppose that the initial hardening of the gear wheel was wasted effort. The wear tolerated in the tire before it superhardened to the extent indicated would have been quite prohibitive in the gear wheel. The initial hardening of the gear wheel was probably insufficient—indeed, if Mr. Herbert is right, was, and of necessity ought to have been, insufficient—to endow the steel with the requisite degree of resistance to wear. It was, however, sufficient and, in fact, was not required to be more than sufficient, to reduce the wear which occurred during the superhardening process to a tolerable amount.

The conception of the real *rôle* played by hardening in the reduction of wear which is deducible from Mr. Herbert's recent investigation may be novel, but there is nothing in it which so far we can point to as being irrational. It implies that the reason why hardening is effective is considerably more complex than had previously been supposed. The lessons of past experience incline us to accept that implication as a point in favour of, rather than against, the new view. From the practical standpoint Mr. Herbert's results, if they can be established on an unassailable basis, will have immediately important consequences. A relatively minor outcome would be the recognition of the fact that a straight test of the initial hardness of a hardened steel part

may be valueless as a measure of the ultimate efficacy of the part to resist wear. Mr. Herbert has found that three samples of steel, all supposed to be of the same composition, which were initially hardened to the same degree had induced in them by subsequent service superhardnesses of widely different amounts. It is of some comfort to note that by means of his "pendulum" work-hardening test Mr. Herbert believes that he is in a position to offer us a method whereby we may determine beforehand the degree to which steel parts, initially hardened or soft, will superharden in service. A much more important practical consideration is the possibility suggested by the research of hardening and superhardening steel parts, before they are put into use, by the adoption of a purely mechanical process, a process eliminating the application of heat to the parts and therefore avoiding the distortion which at present is the bugbear of existing practice. Here again Mr. Herbert is ready to give us immediate aid. In his "Cloudburst" process the articles to be treated are exposed to a blast of small hard steel balls which may subject the surfaces to 200,000 or more impacts per minute. The velocity of the balls is regulated in accordance with the original hardness and the work-hardening capacity of the metal. As the treatment proceeds the velocity is increased, the object sought being to compress and harden the surface of the article without sensibly indenting it. The process is at present, so we understand, under development as a new form of hardness test, but it is evident that it contains the essential features of a method of producing hardness as well as of testing it. There is clearly much room for further work and discussion on the aspects of hardness covered by Mr. Herbert's recent work. One point in particular should prove by itself sufficient to excite interest and possibly criticism. Is abrasion, as Mr. Herbert seemed to admit in the discussion, a necessary antecedent to the production of superhardness? Or is it not simply a common practical accompaniment of the real cause, plastic flow or deformation? Mr. Herbert's "Cloudburst" process, even if the word is used in some special sense, produces superhardness without, we suppose, causing abrasion. The superhardness of the tires, rails, gear teeth and cams examined was, we suggest, not a consequence of the abrasive wear which they had suffered, but a result of the plastic flow which the working conditions had generated. It would, it may be argued, have taken place even if the plastic flow had not been associated with abrasion. The fact that, according to Mr. Herbert, hard metals have in general a greater superhardening capacity than soft metals seems to us to prove that abrasion has nothing to do with the cause of superhardening except as a frequent practical adjunct of the conditions which produce plastic flow.

The Pulverisation of Coal.

THE power absorbed in the operation of pulverised coal machinery is frequently estimated as about 9·4 kWh per thousand pounds of coal dealt with. If we take it that two pounds of coal are required to generate a saleable kilowatt-hour—and there are probably not a dozen power stations in the country that can put a kilowatt-hour on the feeders for less—the power consumed in pulverising would reduce the saleable output and therefore the efficiency of the station by practically 1·9 per cent. With a less economical station the reduction in efficiency would, of course, be proportionally greater. It must not be deduced from this that the use of pulverised coal is more advantageous in an efficient than in an inefficient station. Nor do the above facts justify, by themselves, any argument for or against pulverised coal generally. Whether in any particular case the operating advantages of powdered coal firing exceed or not the extra cost in power and maintenance of the system will depend entirely on the circumstances of the case. The question of power consumption alone is relatively a small one. It is, however, worthy of attention by those who are interested in the development of powdered fuel, for any reduction that can be effected in the power required will almost inevitably bring about a corresponding reduction in the cost and maintenance charges of the pulverising machinery. There are those who will say that the figure of 9·4 kWh per thousand pounds of coal, quoted above, is too high, and that tests can be produced showing as little as 5 kWh per thousand pounds absorbed in pulverising. That may be so, but, on the other hand, equally authentic tests have been published showing a power consumption considerably greater. At the Springdale station of the West Penn Power Company, for example, figures of 12·4 kWh per thousand pounds have been stated, at the Trenton Channel station of the New York Edison Company the average for the first three months of 1925 was about 11·3 kWh, and numerous other cases where the power consumption has exceeded 10 kWh per thousand pounds could be cited. The fact that the power required to pulverise a thousand pounds of coal can vary from 5 to over 12 kWh, the coal being always, by the nature of the case, of a quality purchased with its suitability for pulverisation in view, is a little remarkable. The difference is no doubt partly due to variation in moisture content and in hardness of the several coals, and to some extent to the variation in the fineness of the resulting product; but it seems impossible to correlate these factors with the power required. The principal remaining variable is the nature of the pulverising machine itself. There are, broadly speaking, three methods of pulverising coal employed in connection with power station work. In one the coal is subjected to the crushing action of heavy balls rolling over it, in another the balls are replaced by rollers on rotating pendulum arms swinging outwards by centrifugal force, and in the third the coal is beaten to dust by blows received from rapidly rotating arms while suspended in the air. All are capable of producing the degree of fineness which is generally considered desirable in pulverised coal, namely, such as will permit about 72 per cent. to pass through a screen having apertures of 0·074 mm. and all to pass a screen with apertures of six times that diameter.

No very complete investigation appears to have been yet made into the nature of pulverising processes or the power necessary to reduce coal to a given degree of fineness. Thanks, however, to the work of Mr. Geoffrey Martin, on behalf of the British Portland Cement Research Association, we do know something about crushing sand, and although the stratified and non-homogeneous nature of coal makes analogy dangerous, guidance may perhaps be drawn from Mr. Martin's experiments. He found that, when pulverising quartz sand in a ball mill, the work required was accurately proportional to the increase of surface produced by the process. If, for example, the horse-power hours required to reduce a ton of little cubic grains of sand to grains of half the size are known, the further reduction of the grains to one-quarter their original dimensions would need three times as many additional horse-power hours. This simple relationship between the power required and the size of the particles produced seems likely to hold in the case of coal as well as of sand, for though some coal particles may split up more easily than others, there will be a certain average force absorbed in splitting, and it is reasonable to suppose that this force will be proportional to the area of the new surfaces which make their appearance. Nor is the reasoning vitiated by the fact that every time a fracture occurs a large and indeterminate number of smaller particles, ranging from dust upwards, are generally produced. Each one will have taken a certain amount of power to bring it into separate being, and this power can hardly be other than proportional on the average to the area of attachment which has had to be severed. It is fair to speculate upon the possibility that the work required to pulverise a substance to particles of molecular size should be equivalent to the heat required to bring about volatilisation. Knowing the size and weight of a carbon molecule, we can determine the surface exposed by a pound of molecules. It is sufficiently accurate to say that the whole of this surface has been brought into existence *de novo*, so that if we divide the number of heat units required to gasify one pound of carbon by the number of square feet of new surface, we get the amount of work necessary to increase the surface of a quantity of carbon by one square foot. Coal, of course, is not carbon, and the argument might not hold, even if it were, but the idea is suggestive. Applying it to the case of silica sand ground in a tube mill, Mr. Martin calculates the grinding efficiency of the mill as a small fraction of 1 per cent. only.

The fact that when any piece of coal is broken the fractions are of many different sizes has, of course, an important bearing on the nature of the ultimate product of a pulverising mill. The particles, which regarded collectively constitute the powdered coal, will range individually from those of microscopic size to others which are just not too large to be retained by the screen or other separating device employed in the mill. The same sort of thing, of course, occurs with sand, and in this case Mr. Martin has found the sizes of the particles to follow the exponential law. In other words, if the particles are divided into groups according to increasing size, the numbers in the groups will diminish in exactly the same proportion as the size of the particles increases. Assuming the exponential law to hold for coal, a knowledge of the percentages of the total sample to be found in any two groups of particles will enable the percentages of any other fineness to be calculated. Whether it does hold or not is a matter for experiment. In any event, it must be noted that the law does not imply that if two different pulverisers produce equal percentages of coal of one degree of fineness, they will necessarily produce equal percentages of another degree of fineness. The law may be the same but the parameter different, just as the temperature may drop much more rapidly in one body than in another, though both may be following Newton's law of cooling. A study of the product of different coal pulverising machines on the lines of the investigation carried out by Mr. Martin on sand treated in ball mills might be fruitful. At present we have little knowledge of the relative merits of different kinds of machine from the point of view of uniformity of product. If, at the same time, the minimum power required to attain the desired state of fineness could be determined for a few standard qualities of coal, we should be nearer the point of determining which type of pulveriser was most likely to survive.

The British Association.

No. V. (*Conclusion*).*

SECTION G.—ENGINEERING.

THE JET WAVE RECTIFIER.

ON Monday, September 5th, Mr. Julius Hartmann, of the Hartmann Rectifier Company, Copenhagen, read a paper in which he described the constructive development of the jet wave rectifier. The jet wave rectifier is a mechanical rectifier based on a principle, the invention of which dates back to February, 1907. It has been practically developed in the Royal Technical College, Copenhagen, and in the Municipal Power Station of Copenhagen during the period 1913–1926, and since April, 1927, a 100-kW, 230-volt rectifier has been in operation in an important cable and wire works in Copenhagen. The unit of the rectifier is the jet wave commutator, the main member of which is a wave-shaped mercury jet, the so-called jet wave. The object of the development work mentioned has been to devise a unit commutator of as high a capacity as possible, and at the same time for the highest possible voltage or current. By October, 1926, a stage had been reached when a single jet commutator for 30–40 kW, at about 180 volts, had been developed, and by means of three such commutators working in series, a 100-kW, 500-volt, three-phase rectifier was produced, whilst by means of six such commutators, a 200-kW., 550-volt, six-phase rectifier was put together. The efficiency of the rectifier, excluding the transformer, was stated to be about 92 per cent. at maximum load. The later types of rectifier or commutator have some interesting properties. They are characterised by an absolutely stiff coupling as between the alternating voltage to be rectified and the mechanical movement which affects the rectification. On this account, it is claimed that they are mechanically perfectly stable systems. It has been a generally adopted opinion that it would prove impossible to construct a simple mechanical commutator which would stand the corroding effect of the heavy spark which accompanies commutators of great powers, but it is claimed that the jet wave commutator is subject to practically no wear at all.

SECTION J.—PSYCHOLOGY.

MACHINE SPEEDS AND OUTPUT.

On Monday, September 5th, Mr. F. Wyatt read a paper before Section J, in which he dealt with the question of machine speeds and the ability of the operatives to keep pace with them. In the case of machines running at a fixed speed, he said, the rhythmical nature of the mechanical movements tended to impose a similar reaction upon the operative. Theoretically, he or she was expected to maintain a constant and regular rate of working throughout the day, and to behave almost as mechanically as the machine itself. The living organism, however, was a vastly different structure from a machine, and was subject to very different laws. It was highly probable therefore that the operative might be imperfectly adjusted to the requirements of the machine, or *vice versâ*.

Experiments were carried out therefore for the purpose of obtaining information on that aspect of industrial work. The study of the factors involved in the process of feeding a machine was first attempted in the laboratory, and for that purpose the essential features of an actual industrial process were repro-

* No. IV. appeared September 23rd.

duced. The subjects submitted themselves to tests in which the speeds of machines were varied, and the results, combined with the introspective remarks obtained from the subjects before and after each test, suggested some instructive possibilities. In the first place, the lower speeds were found to be objectionable because of the limitations imposed by the machine. Each subject expressed annoyance at the restricted conditions of work, because of the thwarted desire to spurt at certain periods during the test. As might be expected, that desire to exceed the given rate occurred most frequently in the earlier stages of the test. Secondly, the higher speeds were usually found to be conducive of increased strain and fatigue. Failure to keep pace with the beats of the metronome —with which the speed was controlled—was often disturbing, and the consequent raggedness in the rate of working reduced the pleasure associated with the more rhythmical nature of the work at the medium speeds. Thirdly, the most productive and enjoyable speeds varied in the case of the different subjects.

From the industrial standpoint, the most important feature of the results was the existence of individual differences in the ability to keep pace with the machine. A machine speed which was suitable for one individual might be most disturbing to another, and an optimum speed for each individual worker undoubtedly existed. In industry most machines doing the same kind of work were set to run at the same speed, and while such an arrangement might be favourable to some few workers, others would find the speeds either too fast or too slow. Either the speed of each machine should be adjusted to the natural rate of working of the operative, or workers of approximately equal ability should be selected for the task. All mechanically controlled speeds would, however, be imperfectly adapted to the natural rate of working of the operatives, because of the variations in working capacity at different times during the day. At certain periods efficiency would be reduced, either directly by preventing the operative from exceeding the prescribed rate of working, or indirectly by producing increased strain and fatigue.

The results obtained in the laboratory experiments suggested the advisability of repeating the procedure under industrial conditions, and experiments were carried out in a factory in which operatives were engaged in feeding machines. A preliminary survey of the usual conditions of work suggested that the productive capacity of the operatives was restricted by the speed of the machines on which they worked. In most cases the operatives seemed to have no difficulty in keeping the machines fully supplied with material, and created the impression that a higher rate of working would have been well within their power. That observation was supported by work curves, and there was no doubt that the productive capacity of the operatives, and consequently the welfare and interests of the firm, were seriously impaired by the unnecessarily low speeds of the machines. Evidently the speed was set to coincide approximately with the rate of working of the slowest operative, but such an arrangement was obviously undesirable, and a serious handicap to production.

A number of tests were made to ascertain the effect of different machine speeds on productive activity. They indicated that the operatives were usually unable to approach their maximum rate of working because of the limitations imposed by the speed of the machines. Further, when the machine speeds were increased for experimental purposes, the operatives responded successfully to the additional demands until the speed attained exceeded the original rate by approximately 18 per cent., and there was little doubt that some of the more efficient workers were capable of coping with still higher speeds.

In any group of individuals selected at random, considerable differences in ability would be found to exist. It was quite common, for instance, to find differences in efficiency amounting to 30 or 40 per cent. in repetitive handwork, where working capacity could be fully expressed in productive activity. In the investigation described, the operatives of superior ability were practically reduced to the level of the least efficient workers, because of the limitations imposed by the speed of the machines. By suitably increasing the machine speeds, there was little doubt that the productive efficiency of the process could be increased by from 10 to 15 per cent. without increasing the fatigue or discomfort of the operatives.

SECTION L.—EDUCATION.

EDUCATION AND INDUSTRY.

On Monday, September 5th, Section L discussed the association between education and industry. The Duchess of Atholl, D.B.E., President of the Section, was in the chair.

Mr. T. Wickham Murray, secretary of the Association of Teachers in Technical Institutes, in a paper on "New Outlooks and Tendencies," said that to-day the technical colleges provided the best link between education and industry. Almost everybody was convinced of the need for a closer *liaison* between the two for the benefit of the large proportion of the population who sought a living in industry and for the improvement of industry itself, but unfortunately there was as yet no adequate national policy under which the two could be brought together for their mutual benefit. Such a policy could not be formulated without a revision of some of those ideas which at present make up our educational philosophy.

Industry definitely asked for a more intimate *liaison* between those responsible for the country's industrial life and those responsible for technical education. Industry believed that technical education was absolutely essential, and that the time was now ripe for an advance. With proper co-operation between educationists and industrialists immediate advances should be effected along the lines of the grouping of educational facilities, the content of the curricula, the supply of efficient staff, and research.

Mr. E. Walls, of Messrs. Lever Brothers, discussed the educational needs of industry, and pointed out that 97½ per cent. of pupils entered industry in some form or another, and educational plans should have the working life of the pupil in mind from start to finish. Stressing the need for greater co-operation between the schoolmaster and the employer, he said that industrialists were not alone to blame for the slowness of the forging of the link between industry and education; sometimes it seemed that the educationist had worked out his plans in that direction in the remote atmosphere of a vacuum.

The two classes engaged in industry were the managers and the managed, and the greatest need of industry was trained managers. Just as machines had to a large extent swept away manual work, so the limited liability company had replaced the employer by the business organiser. The business manager had become a professional man, but whereas other professional men, such as accountants, lawyers and so on, had a specific vocational training, the professional business organiser had not. The defects of present-day business managers, which were very serious, could be traced back to educational deficiencies.

With regard to elementary education, his feeling was that we should teach less rather than more. He favoured the retention of the school-leaving age, but hoped the day would come when some compulsory general education—physical and mental—would be universal up to the age of sixteen or eighteen, merging gradually into vocational training. The great thing to aim at was continuity of education, and he regarded that as far more important, from the standpoint of industry, than the raising of the school-leaving age could possibly be.

Mr. J. H. Everett (Leeds Technical College) dealt with the technical colleges and their courses and problems. Speaking of the need for the whole-hearted support of industry, he said there was a real need for more advisory committees than at present exist. He had seven advisory committees, each dealing with particular industries, such as engineering, &c., consisting partly of employers and partly of operatives from the trades unions and any other bodies interested in technical education in the particular industries. They met regularly and discussed the various matters connected with the training of pupils, but he was convinced that more could be done. There were needed not only local, but national advisory committees, and educationists were ready to meet the employers in order to be able to supply what the latter needed.

Dr. H. Schofield, in a paper on "Engineering Training and Production," said that although the subject of training the engineer was one full of controversy, which did not apparently grow any less as experience proceeded, there was yet one point upon which we had almost complete unanimity, namely, that somewhere in the training of the engineer must come time spent in actual practical experience on productive output. It might precede or follow a university or higher technical college training, according to the views held by those responsible for placing students in such institutions. There were difficulties whichever way the course was taken, and it was in an endeavour to get over those difficulties that the scheme of training now in progress at Loughborough College was founded.

In the institutions reponsible for the theoretical side of a student's training, other difficulties inherent in the system were found. There was a tendency, which would grow alarming unless carefully checked, for the college or university responsible for technological training to become dissociated from the industry for which it was responsible for training recruits. University courses in engineering and allied technology were designed, perhaps of necessity, on a mathematical and physical basis, yet for an all-round engineer there were three aspects of training, each of which was equally important. These were (1) its mathematical and physical side; (2) the question of management; and (3) the art of selling, distributing and obtaining a market. The so-called engineering workshops in our larger technical institutions tended to become laboratories rather than workshops in the real sense of the term.

In the productive college the exercise was abolished in every section. Graded production suitably selected, giving the maximum variety of experience, was substituted from the beginning. Again, however, difficulties occurred. The right type of instructor was not easily found; the cost of scrap might prove serious, unless carefully watched; the attitude of interested people might not always be sympathetic; and last, but by no means least, delivery was a formidable trouble. On the other side, the advantages were overwhelming. A student was interested, keen and enthusiastic; he felt that he was working to some purpose and that his work had a value which could be assessed commercially within his own experience; his practical work was in direct and constant touch with his theory in the lecture room and laboratory. At the end of a five-year course, he had had a reasonably wide experience for a young man of his age, and he knew something of the relative costs of the application of his theoretical knowledge.

Mr. A. P. M. Fleming, manager, research and education departments, Metropolitan-Vickers Electrical Company, discussed the educational facilities provided by firms in an attempt to meet the industrial educational needs of their juvenile employees under two divisions, namely, the educational facilities of what might be termed the conventional type, that is to say, education arising from instruction intended to be either cultural or vocational and following the lines of the recognised educational methods; and that education of a much broader type which was directed towards enabling a person to live and work in harmony with his fellows. Until recent years very little had been done by industrial firms to provide facilities for vocational education for their workers, but at the present time in London alone, 176 firms were co-operating with the London County Council in sending 5322 students to 65 institutes. The present arrangements, however, only touched a very small proportion of the juveniles in industry, and however important they might be as an experiment, and however much they might benefit isolated cases, they could not be recognised in any sense as the real solution to the continuation education problem. Naturally the industries which were based on the application of scientific knowledge, as, for example, engineering, were among the first to recognise the value of their workers continuing their education, especially of a technical character, so that the engineering industry stood out pre-eminently as one of the pioneers in continuation education, and engineering employers had always led the way in matters concerning industrial education. Similarly, in other big industries where apprenticeship systems prevailed, it was the exception to find that definite educational schemes did not form a part of the training of the apprentice.

The gas light and coke industry, whether municipally organised or controlled by limited liability companies, was outstanding in its belief in the education of its workers, and had training schemes applicable to engineers, chemists, gas supply pupils, and clerks. The Gas Light and Coke Company made attendance at either its own or London County Council classes—whichever were applicable—a condition of employment, while the juvenile employees of the gas and coke department of the Birmingham Corporation attended a day continuation school for a whole day a week in their first year and evening classes conducted by the local education authority's teachers or the gas department's staffs subsequently. Similarly, the various railway companies, and most notably the London and North-Eastern group, had very adequate facilities for securing continuation education for their workers. In shipbuilding there were one or two instances of instruction being given by the firm, and others of instruction being given by the firm in co-operation with the local education authorities. In apprenticeship in H.M. dockyards the training consisted partly of practical instruction and partly of education in the dockyard schools, which were established as far back as 1843.

In the engineering organisation with which Mr. Fleming is associated perhaps the most interesting facility, he said, was that associated with the company's scheme of apprentice training. The Apprentice Association, as it was called, included all grades of apprentices—trade, pupil and student. It was governed by a council which consisted of officials drawn from each of the two sections of the association, namely, the "trade" and "school and college" section. It was in that direction and by providing facilities for that form of education for both juveniles and adults, continued Mr. Fleming, that industry could carry out a real educational function. In the setting up of such facilities the great danger was for too much to be done by the officials of the company. Only the societies, institutions and committees that arose from the conscious needs of the workers, which might have been fostered and developed under wise guidance, but are eventually controlled by the workers themselves, would fulfil their educational function and live. In the organisations where too much assistance, whether financial or in other directions, was given—where workers were inclined to be spoon-fed—their institutions lacked spontaneity and lost much of their potential value.

SECTION G.—ENGINEERING.

INTERNAL COMBUSTION ENGINES.

There was a full programme of papers in Section G on Tuesday, September 6th.

The first paper was by Professor W. T. David, and dealt with the ideal efficiency of internal combustion engines. Two suggestions were put forward in this paper. (1) That the ideal efficiencies of internal combustion engines calculated upon the basis of the generally accepted specific heat and dissociation data are too low, and (2) that the ideal efficiencies increase with compression ratio at a rate not only greater than

that indicated by the air standard, but also greater than that indicated by ideal efficiency calculations based upon the usual specific heat data.

Experimental work, said Professor David, had been carried out during the last few years at Leeds in conjunction with Messrs. S. G. Richardson, W. Davies, R. A. Smith and B. H. Thorp upon explosions of inflammable gaseous mixtures contained in closed vessels by means of flame photography and optical indicators. The experiments indicated that the usually accepted values for the specific heats at high temperatures of gases constituting the products of combustion were too high, and that the usually accepted dissociation values were too high. The reason was that specific heat and dissociation values had been calculated from explosion experiments on the assumption that the whole of the gaseous mixture had been burnt and was in thermal equilibrium by the time the maximum pressure was reached. The flame photographs, together with pressure measurements on explosions covering a wide range of mixtures in which the proportion of H_2 or CO and O_2 and N_2 were varied, showed that that assumption was not justifiable, even in the case of those explosions in which a large excess of the reacting gas was present. The significance of that conclusion in connection with internal combustion engines was that the ideal efficiencies calculated on the basis of specific heat and dissociation values deduced from explosion experiments were too low. Engine experiments by Mr. H. Ricardo supported that view. He had found that the measured thermal efficiency of an engine approached too closely to the ideal value calculated upon the basis of the generally accepted specific heat values to give one confidence in the latter

Closed vessel explosions also showed that for a mixture of any given composition the ratio of the maximum pressure reached on explosion to the initial pressure of the mixture before explosion increased as the initial pressure was increased. Professor David suggested that the causes were, first, more complete combustion with increasing density, and, secondly, that the specific heats of CO_2 and water vapour at high temperatures decreased with increasing density. Engine experiments by Messrs. Tizard and Pye showed that the thermal efficiency of an engine working on a mixture of any given composition increased as the compression ratio increased to a greater extent than that to be expected from their efficiency calculations, which were based upon specific heat values assumed to be independent of density. If, as he suggested, combustion became more complete in the early stages of the expansion stroke, and the specific heats of the products of combustion at high temperatures decreased as the density increased, the explanation was clear.

Professor F. C. Lea thought Professor David was rather bold in putting forward some of his definite conclusions as the result of his experiments. He asked the author whether from his work he would suggest that we should still retain the ordinary air cycle as a standard reference for gas engines or whether we could now reconsider the whole problem and adopt some standard cycle of reference which would do for all types of internal combustion engines.

The President said the paper seemed to call for one or two definitions. The first was, When is burning complete? He took it that burning was complete when thermo-chemical equilibrium was established. Unless some such definition as that was adopted, some arbitrary datum of temperature must be established. It was difficult to say when burning was complete, because undoubtedly there was some delay owing to the walls themselves. There was a layer of cold gas in contact with the walls and that must affect the indicator diagram. It also affected the flame in the gas, and Professor David's diagrams must be read with that in mind, viz., that there was a possibility of that layer of cold gas in contact with the walls burning after thermo-chemical equilibrium had been established in the centre of the gas, and masking what was happening inside the body of the gas. From that point of view, the flame was not a good indicator, but it was difficult to see where one could get a better. Professor David's experiments were one thing and his theory was another. The experiments might stand, but he was a little bit doubtful about the theory, and he would like to know what was meant when the author spoke of burning being complete.

Professor W. Cramp remarked that Burstall at Birmingham had carried out a number of experiments on gases containing CO and oxygen, and he had traced a quite definite time delay in the burning of the gas from the centre outwards. He believed he was right in saying that the time taken for the burning of the gas from the centre outwards was of the same order as the time to the rise to maximum pressure in the author's experiments. In other words, the Birmingham experiments of Burstall showed distinctly that apart from the layer of cold gas near the walls, combustion was taking place comparatively slowly through the mixture.

Professor David, in his reply to the discussion, pointed out that although Professor Lea had charged him with being bold in putting forward his conclusions, Ricardo, who was an exceedingly careful investigator, had actually measured a thermal efficiency of 33 per cent. for an engine for which the calculated ideal was 36 per cent. Tizard had also worked on the same lines, and both Ricardo and he would agree that in view of the known losses of heat in that particular engine, the proportion of the ideal realised, according to present-day calculations, was altogether too high. Professor Lea had raised a rather wider point, however, when he spoke of ideal indicator diagrams. Personally, he thought he had shown enough by his experiments to indicate that we could not do better than stick to the air standard for the moment. What that particular air standard should be, however, was a rather difficult matter. He had rather expected the question from the President as to when burning was complete. The paper had been written by him as a mere engineer, and what he meant by burning, *i.e.*, combustion, was the overall process of conversion of chemical energy into the products of combustion, into CO_2 in its normal form, and not in the activated form or anything of that kind. The President had also suggested that flame was not a good indicator for following the combustion processes in the explosion vessel on account of the fact that there was a surface layer which was constantly burning. He did not appreciate that difficulty himself, although he would have, had he been working under the enormous densities that the President used.

Centrifugal Pumps.

A paper on "Low Lift Axial Flow and Centrifugal Pumps," by Messrs. H. R. Lupton and J. H. W. Gill, was presented. Whilst entering considerably into the theory of the design of axial-flow and centrifugal pumps, it was mainly concerned with demonstrating the superiority of the former over the latter for certain service. No claim was made, however, that the axial-flow pump would displace the centrifugal pump for all classes of work. It was pointed out that the object of the axial flow pump was mainly to deal with the low heads frequently met with in irrigation schemes, dock works, sewage disposal, condenser circulating, &c., being a type which was intermediate between the screw and centrifugal pumps. An examination of the characteristic curves revealed the following points in favour of the axial-flow pump:—

(*a*) As the head decreases the quantity increases, notwithstanding which the power absorbed by the pump diminishes.

(*b*) A very great head can be obtained—about thrice the working head—at no delivery.

(*c*) The efficiency is maintained over a very wide range of heads.

(*d*) The high specific speed, especially in the case of the axial pump.

(*e*) The small proportion of the total energy which has to be converted from the kinetic to the pressure form by the guide vanes.

(*f*) Compactness.

(*g*) Freedom from choking.

In order to explain these characteristics and generally to contrast the behaviour of the axial and axial-radial pumps with that of the ordinary low-lift centrifugal pump, a graphical analysis was given in the paper.

Transport on the Farm.

Mr. Borlase Matthews dealt with "Transport on the Farm" in the next paper. Agriculture, he said, had now arrived at the stage where the problem of the introduction of considerably more machinery and the electric power to operate it, must inevitably be faced. Farming had seriously lagged behind all other industries in the use of power—particularly of electric power—and many farm duties were carried out just as they were one hundred years ago.

Discussing transport from field to barn, the author showed lantern slides illustrating mechanical and electrical methods for replacing hand methods. Although a portable folding hay elevator for building stacks was often seen, and was a step in the right direction, it still required man labour to fork the load on to it from the wagon. In England it was often horse-operated though rarely electrically worked. A great improvement in the method of handling a crop was to utilise specially prepared slings or automatic grapple forks in place of the elevators, the sling method being preferred as the carts could be unloaded in one lift. A three to five horse-power motor was large enough to drive the winch. Another method was to equip the wagon with removable wooden skeleton platforms. The "Temperley" type transporter for lifting complete cart-loads of crops was mentioned. Mention was also made of the advent of an entirely new class of very light and cheap transporters, conveyors, &c., which were available for farm purposes, it being emphasised that in a heavier construction the use could not have returned the interest and depreciation on the capital.

Electrically-driven portable chain conveyors should be employed to transport the sheaves from the rick yard or barns to the thrashing machine, and an automatic device could be incorporated on the thrashing machine for cutting the bands on the sheaves and spreading out each sheaf before delivering it on to the thrashing drum. With the introduction of mechanical delivery devices the thrashing machine could be permanently mounted on foundations at about 4ft. above the floor level, thus leaving ample room for bagging, &c., when required. When permanent thrashers were installed, the straw leaving the machine could be either baled or passed into a sheaf binder, or blown to the straw yard through a tube, or transported by an inclined elevator. With all methods, except the pneumatic tube method, the straw should eventually be delivered on to a horizontal conveyor. At convenient intervals, trap doors placed in the run-way of the horizontal conveyor permitted of the delivery of the straw at any desired point. The length of pneumatic delivery tubes could be as much as 200 yards, and the tubes were usually made up of 10ft. lengths of light galvanised piping. A 5 horse-power motor driven fan carried grain or straw for a distance of 50 yards, an 8 horse-power motor would double the distance, and a 10 horse-power size would carry 200 yards. Even smaller motors could be employed if efficient fans were used and attention was paid to the ejecting device.

A number of other ways of applying power to the farm were indicated, and, in conclusion, the author declared that the introduction of electro-mechanical appliances for all farm buildings was relatively simple if farming was carried on on modern lines.

Transmission of Power by Belts.

The final paper on Tuesday, September 6th, was on the "Transmission of Power by Belts," by Mr. H. W. Swift, of the Bradford Technical College. The author also described an experimental equipment installed at the College for the testing of belts under running conditions.

The fundamental principles of the operation of a driving belt, he said, were still incompletely understood; in particular, opinion on the mechanism of creep and slip was still divided, and relations obtained by causing a belt to move slowly over a stationary pulley were still applied to running conditions. Discussion of the transfer of power by an extensible belt showed that so long as the tension ratio (T_1/T_2) was less than that ($e^{\mu\beta}$) corresponding to the limiting co-efficient of friction and angle of embrace, relative motion on either pulley would occur only over the "active" arc of embrace, which extended back from the point of leaving through an angle β where $T_1/T_2 = e^{\mu\beta}$. The successful operation of crowned pulleys and twisted drives depended on that fact. Preliminary experiments demonstrated that "static" tests did not enable the running characteristics of a belt to be predicted.

Reinforced Concrete, Water Conduits, and the Whirling of Shafts.

As usual, the main work of the Sections was completed on Tuesday, September 6th, but one or two sectional meetings were held, including Section G, on September 7th, at which three papers were read.

The first was by Mr. J. Gilchrist, of the Leeds University on "The Strength of Reinforced Concrete Beams in Shear." In 1915, Mr. Gilchrist showed that given two reinforced beams, one with straight tension reinforcement hooked at the ends with no shear reinforcement, and another with the same tension reinforcement and vertical stirrups in addition, then the strength added by putting in the vertical reinforcement bars could be calculated by a certain formula. From certain published information, the author had found that in beams made of a concrete having a compression strength of 1·4 tons per square inch, and with horizontal tension members hooked at their ends, but with no verticals, the failing shear would be 275 lb. per square inch. Mr. Gilchrist had been carrying out experiments to ascertain how the shearing strength of beams varied with the strength of the concrete, the figure of 275 lb. per square inch serving as a convenient connecting link. The beams were of T section with a flange 5in. wide by 1in. thick, a web 2in. wide and a total depth approximately of 4in. The span was 30in. and the load was applied at two points, 10in. and 20in. from the end. There were reinforcing bars near the bottom of the beams with large hooks at the ends, and there was no web reinforcing in any of the beams. The bars were $\frac{3}{8}$in. diameter of mild steel, and the number varied from two to four, corresponding to from 1 to 2 per cent. of the rectangle enclosing the cross section of the beam. With each beam compression test pieces of 4in. cube and tension test pieces 1in. square at the middle and tapering outwards to the ends in the usual way, were made. Compression and tensile tests were carried out at the same time as each beam test. The cement used was a quick-hardening aluminous cement, Ciment Fondu. The aggregate was crushed millstone grit passing through a $\frac{1}{4}$in. riddle, and there was no sand, except the small grains of the crushed rock passing through the riddle. The proportions used were 8 to 1, 5 to 1, and 3 to 1. With that range of mixtures the compression strength varied from 1000 lb. to 8000 lb. per square inch. The proportion of water used was 13$\frac{1}{2}$ per cent. of the total weight of cement and crushed stone. It was shown that the results of compressive and tensile tests of concretes used in the beams tested could be expressed in terms of the tensile strength by the following formula:—$C = 12 (T - 100)$, where C was the compressive strength of the concrete and T its tensile strength, both in pounds per square inch. Above a compressive strength of 5000 lb. per square inch, however, there was not the same increase in the tensile strength for the particular kind of aggregate used. The following table gives the practical minimum values of the shearing stress at the neutral axis near the end of the beam, calcu-

lated on the ordinary beam theory from the results of the tests :—

		C.S.D.C.		C.S.B.L.	
C.	T.	1 % steel.	1¼ % steel.	1% steel.	1¼ % steel.
1000	183	160	210	290	350
5000	520	290	420	350	500

C and T are the compressive and tensile strengths of the concrete, C S D C is the calculated shear stress under the load at which the first crack was seen in the region of greatest shear, and C S B L is the calculated shearing stress at the breaking load. All the figures are in pounds per square inch. As mentioned, the author had previously stated that for a concrete of about 3000 lb. per square inch compressive strength the failing shear stress of a beam would be 275 lb. per square inch, that being a conclusion from published tests. In the above table the corresponding figure would be the mean of 290 and 350, *i.e.*, 320 lb. per square inch. The following conclusions were drawn from the tests :—(1) The calculated shearing stress at the first diagonal crack may be less than the tensile strength, and the calculated shearing stress at the breaking load may be greater than the tensile strength of the concrete. (2) The calculated shearing stress at the first diagonal crack, or at the breaking load, does not vary in the same proportion as either the tensile strength or the compressive strength. If beams of high compression concrete are taken as the standard of comparison, then the beams made of weak concrete are very much stronger than would be expected ; or, if beams made of weak concrete are taken as the standard of comparison, then any increase in the strength of the concrete does not give a proportionately greater strength of beam. (3) The calculated shearing stress, both at the first diagonal crack and at the breaking load, is affected by the amount of the tension reinforcement.

A paper followed by Mr. H. H. Burness on "The Design of Large Low-pressure Water Conduits." This was a detailed mathematical treatment of the problem involving the use of elliptic integrals. As tables of this nature are not ordinarily available to the designer, the series of values which the author works out and tabulates for a constant vertical diameter of 10ft. will be valuable. For larger or smaller conduits, the dimensions have simply to be increased in proportion and the areas varied as the squares of the vertical diameters. The paper also compares the economy of the closed type of conduit for power purposes, with the cost of an open channel, taking into account the loss of power involved in the unavoidable lowering, in the latter case, of the channel owing to various obstructions and the natural features of the ground. The results, of course, depend entirely upon the particular circumstances, and cannot be regarded as of general application.

The final paper was a short one by Mr. T. M. Naylor on "The Whirling of Shafts," in which he pointed out that a discussion took place some years ago as to whether there was a disturbance before the whirling speed proper. A further discussion took place as to whether the disturbance occurred at ½ or $\frac{1}{\sqrt{2}}$ of the whirling speed proper. The paper describes some recent experiments on the subject, and at the same time gives a brief summary of the matter published on the point. Experimenting with an overhung shaft loaded at the end, the author comes to the conclusion that there is a disturbance at ½ the whirling speed proper. The experimental work was carried out in the engineering laboratory of Leeds University.

The Shipping, Engineering and Machinery Exhibition.

No. IV. (*Conclusion*).*

SIR W. G. ARMSTRONG, WHITWORTH AND CO., LTD.

The stand arranged by Sir W. G. Armstrong, Whitworth and Co., Ltd., although it did not readily lend itself to description and illustration, was nevertheless representative of all branches of the firm's engineering, shipbuilding and locomotive manufacture, as well as small tools, machine tools and steel products. Shipbuilding was represented by several fine models and photographs of vessels recently constructed, as was also the firm's locomotive department. A lathe and various small tools were arranged for inspection. We may perhaps specially refer to the samples of Vibrac steel which were on view. This is a molybdenum steel, which has been specially produced to meet the requirements of highly stressed machine parts. It can be oil quenched or air toughened, and has very high impact and other test values. Vibrac steel is now cast, we learn, in ingots weighing from a few hundredweights up to 120 tons.

PERCY PITMAN.

Mr. Percy Pitman, of 25, Victoria-street, Westminster, was showing the Pelton wheel illustrated by Fig. 70, which is fitted with an improved form of the deflector governor described in THE ENGINEER of February 12th, 1926. The peculiarity of this governor, it will be remembered, is to split the jet of water in two, when it is deflected from the wheel on the load going off. By this means the forces of reaction on the deflector are balanced and the governor has practically no work to do in moving the deflector, except that necessary to overcome friction. As a consequence, a comparatively light governor can be used to secure a delicate control of the wheel, a fact which may be gauged by the small size of the governor casing seen on the end of the spindle in Fig. 70. The principal change in the design of the deflector is the arrangement of its two sectors at different radii, so that it can be turned through a larger angle before it becomes fully effective. On the same stand there was also a small water-driven generating set suitable for charging accumulators or lighting small houses.

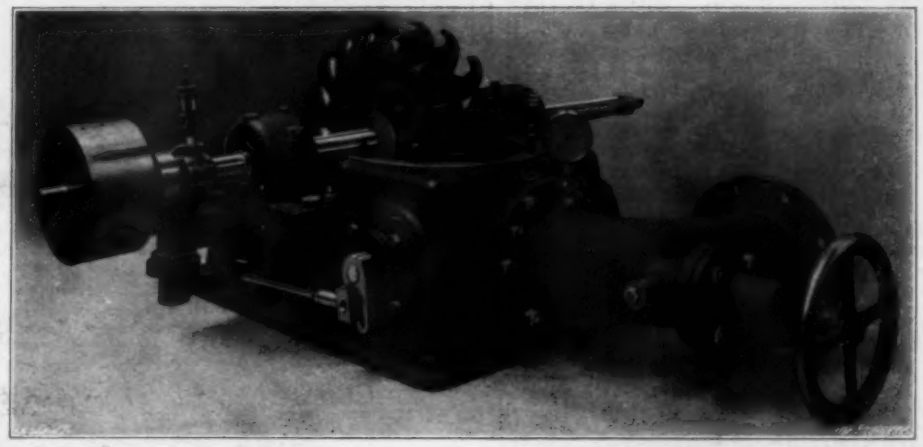


FIG. 70—85 B.H.P. PELTON WHEEL WITH DEFLECTOR GOVERNOR—PITMAN

SCOTT AND HODGSON, LTD.

The exhibits which were to be seen on the stand of Scott and Hodgson, Ltd., of Guide Bridge, Manchester, were mainly confined to the lighter productions of that firm. We have chosen for illustration in Fig. 71 a turbine and generator similar to one of several small turbo-electric generating sets which were displayed at Olympia. The design of turbine which has been developed by Scott and Hodgson, Ltd., for auxiliary work is that of the radial flow velocity compounded impulse type. It is built in various sizes, ranging from ½ up to 150 horse-power, and may be employed for driving fans, pumps or generators, or working with geared drives. The turbines have also been used over a very wide range of pressures, some installations working at a few pounds steam pressure and others at gauge pressures up to 200 lb., and exhausting either to a condenser or against back pressures up to 35 lb. and 40 lb. where a supply of heating or process steam is required. An interesting application of such a turbine which, however, was not shown at Olympia, but will shortly be put on the market, is a small turbine generator unit for the lighting of locomotives, cranes and docks. The firm also displayed a working exhibit of its patented preventive device for overspeeds and overwinds on electric or steam winding engines, which apparatus is combined with a depth indicator.

As makers of the new Capell impulse fan for mine, colliery and tunnel ventilation, many units of which have been supplied to undertakings both at home and overseas, the firm exhibited a small fan of this type, which enabled its principle to be demonstrated.

MARTIN'S FEED-WATER OIL GAUGE.

On the stand of Richard Klinger and Co., Ltd., of 120, Southwark-street, S.E. 1, there was to be seen some examples of Martin's patented feed-water oil gauge, which, we understand, is used extensively in the Dutch mercantile marine, to enable engineers to determine accurately and quickly the amount of oil in form of emulsion which is present in boiler feed-water. With the increase of boiler pressures some apparatus of this kind is becoming necessary. It should also be useful on board ship and on land to check the amount of oil actually remaining in bilge water after it has been treated by one of the many oil-separating methods in order to satisfy the requirements of Port Authorities. The gauge is a very simple piece of apparatus, for it consists of a glass tube with a length of about 17in. and an outside diameter of ¾in. The closed end of the tube is made of white porcelain, and has a conspicuous black spot about one ¼in. diameter placed at the centre. The outside of the tube is suitably engraved with a scale of grains of oil per gallon of water (or milligrammes per litre). When using the instrument the feed-water to be tested is poured slowly into the tube, during which operation the black spot is observed from above through the liquid. As soon as the black spot is on the point of becoming invisible, when held in good light, the height of the column of liquid in the tube is read off on the scale, giving the number of grains per gallon (or milligrammes per litre) of the oil present in the water. Various sizes of tube are made to suit special conditions, reaching to 1 grain, ½ a grain, and a ¼ grain to the gallon. One special use, we understand, is the comparison of the relative concentration of sugar in solution in sugar factories. The apparatus is also used in electrical power stations and pumping stations, and many other industries

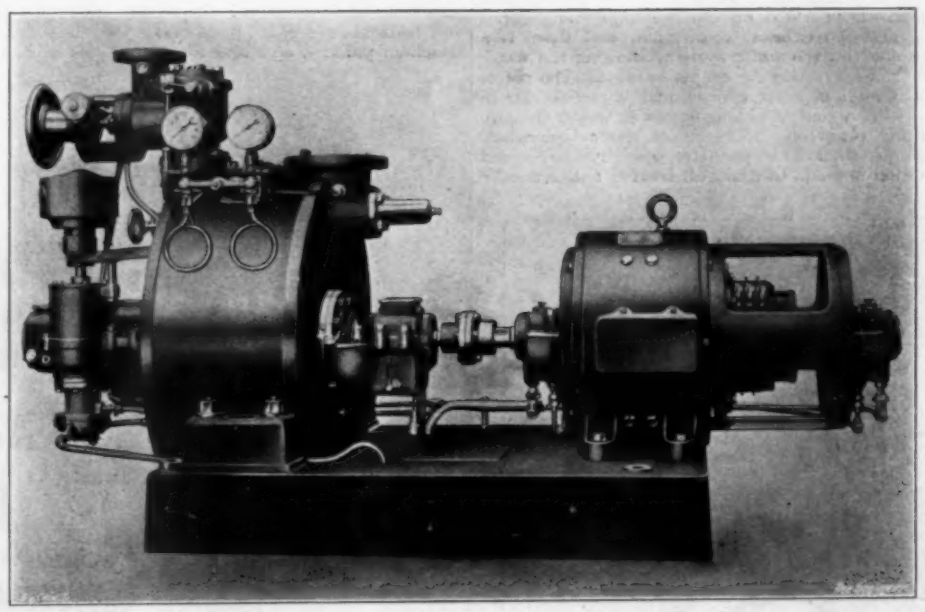


FIG. 71—STEAM TURBINE GENERATOR SET—SCOTT AND HODGSON

* No. III. appeared September 23rd.

where a pure supply of water is required. The gauges may also be obtained from Frederick A. Pullen and Co., Empire Works, 58, Harleyford-road, Vauxhall, S.E. 11.

WALTER D. FAIR AND CO.

An interesting exhibit on the stand of Walter D. Fair and Co., of Hampton Wick, Kingston-on-Thames, was a detachable twin-cylinder inboard marine motor of the firm's well-known 6 B.H.P. Watermota pattern. We illustrate this particular engine in Fig. 72. It was designed so that it could be quickly removed from a yacht's tender and just as quickly bolted down to a prepared seating on the yacht in order to fulfil lighting or pumping duties. As our illustration shows, the engine rests on two "sherardised" steel bearers, which are provided with locating studs. The engine baseplate is always kept in true alignment by the studs. It is

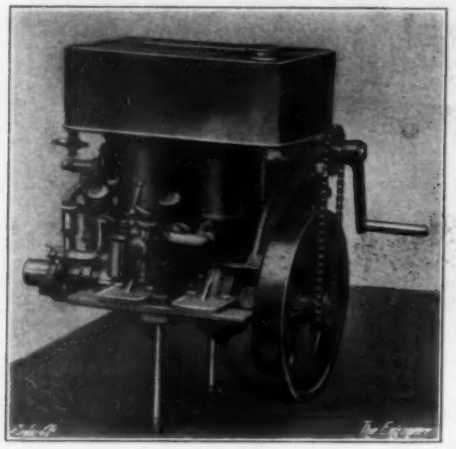


FIG. 72—6 B.H.P. DETACHABLE MOTOR—FAIR

secured to the bearers by two strongbacks, made of manganese bronze, which are held in position by two ⅜in. diameter bronze bolts. By unscrewing the nuts and swinging out the strongbacks, the unit, which only weighs 80 lb., can be lifted off the bearers in the tender and transferred to a similar seating aboard the yacht. A quick-release propeller shaft coupling with two hinged bolts is provided, which may be seen to the left of our engraving. This arrangement enables the engine to be detached from the propeller gear by unscrewing two bolts. Each nut, both on the propeller coupling bolts and the two strongbacks, is so secured that it cannot be screwed off its bolt and lost. Pipe unions of the screwed pattern are provided on the water inlet and outlet pipes and the exhaust connection, and there is a drain cock on the water system, allowing the water to be run off before the engine is lifted. The petrol tank is built of sheet copper, and is rectangular in form with a central oblong space in which the two sparking plugs on the heads of the cylinders are accommodated. This space is enclosed by a cover, and provision is made to drain off from it automatically

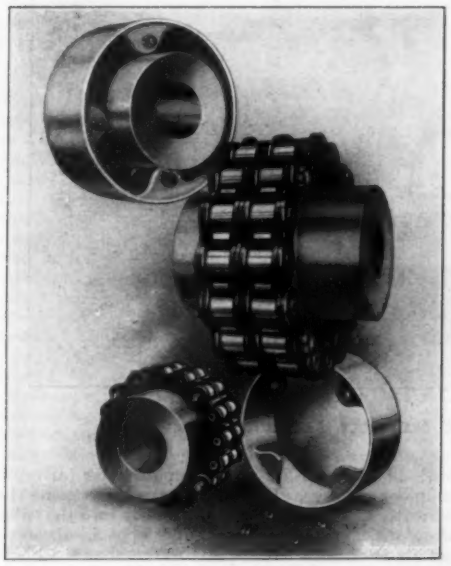


FIG. 73—COVENTRY CHAIN COUPLING

any water which might collect there. The firm also showed examples of inboard and outboard marine motors, both with reversing and solid types of propeller gear.

THE COVENTRY CHAIN COMPANY, LTD.

Various kinds of chain transmission gears and a chain-driven speed reduction unit were exhibited by the Coventry Chain Company, Ltd., of Coventry. We have chosen for illustration, however, the firm's type of chain coupling, which has been introduced to meet the demand for a positively driven non-rigid coupling which will have long life, under heavy load conditions. As the illustration, Fig. 73, shows, the flanges of the coupling are provided with gear teeth into which is meshed a length of standard duplex roller chain provided with joining bolts at regular intervals. The coupling is machined all over, and, owing to the good balance thereby obtained, and the even division of the stresses over the teeth on the coupling, it is claimed that a larger horse-power can be transmitted than is possible with other types of coupling having similar dimensions. With the form of coupling shown relative end movement between the two shafts up to one-sixteenth of the shaft diameter can be allowed. The range of couplings of this type embraces small magneto drive couplings up to couplings with a bore of 4in. to 5in. Where desired, covers are fitted over the chain, as shown in our illustration, or light aluminium cases to retain grease and exclude water or other liquids, may be employed.

GREENWOOD AND BATLEY, LTD.

The stand of Greenwood and Batley, Ltd., of Leeds, was devoted to a display of variable stroke pumps and transmission gears, built under the Hele-Shaw-Beacham patents, and also some examples of small steam turbines of the De Laval type. We have chosen one of the latter units for description. The generating set—illustrated in Fig. 75—is a 20 B.H.P. De Laval single-wheel impulse type turbine, running at a normal speed of 20,000 r.p.m., and coupled to a 13·2 kW 2000 r.p.m. 110-volt dynamo through single reduction double-helical gearing. In the new type of machine a solid turbine shaft is employed instead of the thin flexible shaft of the earlier machines. The set, which was designed for ship lighting service, may exhaust into a condenser or to atmosphere, or may exhaust into a heating system against a back pressure. The centrifugal governor operates direct upon a double beat governor valve, while there is an emergency overspeed governor which is arranged to trip the main stop valve in the case of excessive turbine speed. Both the gearing and the high-speed bearings are arranged for forced lubrication, the oil being supplied under pressure by an oil pump accommodated in the bed-plate of the machine, and driven by a worm wheel on the gear shaft. The new design of turbine, gearing, and generator, which we illustrate, has an overall length of 4ft. 2½in., which is shorter by over 2ft. than the earlier type of machine, and the total weight of the set has been reduced from 20 cwt. to 11 cwt.

LAURENCE SCOTT AND CO., LTD.

One of the largest exhibits of electrical machinery was undoubtedly that of Laurence Scott and Co., Ltd., of Norwich, whose products were represented not only on the firm's own stand, but also on many of the marine and industrial exhibits shown on other stands. Many of the exhibits were arranged as working examples, which gave them added interest. We single out for description and illustration one of the firm's 1927 type of cargo winches, which is shown in Fig. 74. The winch is of the worm geared type, and as the engraving shows is constructed to form, along with its contactor controls, a compact unit. On the top of the motor is the control gear operated by a short handle, which works the starting and reversing motions through a system of controls embodying a timed mercury dashpot, thereby making the gear suitable for handling by unskilled attendants, as it can withstand the roughest usage. Below the control handle is the hand release lever for the magnetic brake, while the foot brake is arranged in a convenient position at one side of the winch. All parts of the mechanism and the contactor gear are weatherproof, and all wiring connections are enclosed, an isolating switch and cable connection being provided outside the winch. The machine we inspected

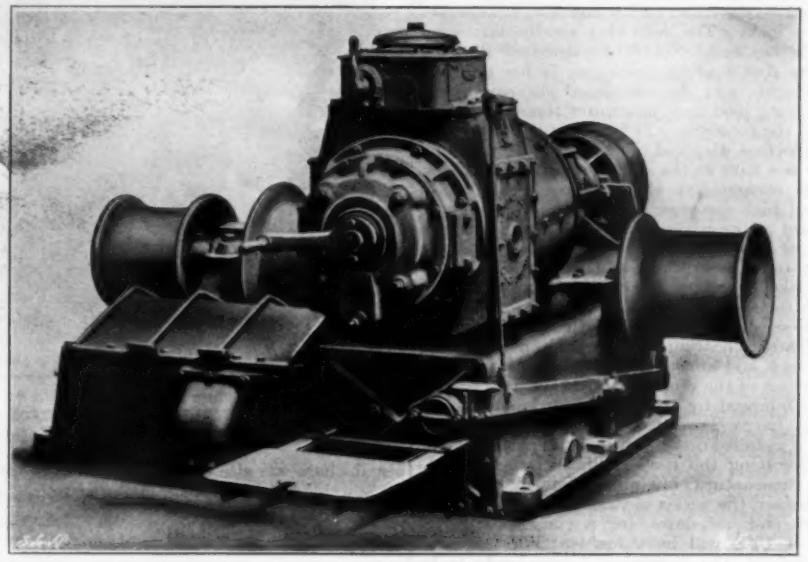


FIG. 74—3-TON ELECTRIC CARGO WINCH—LAURENCE SCOTT

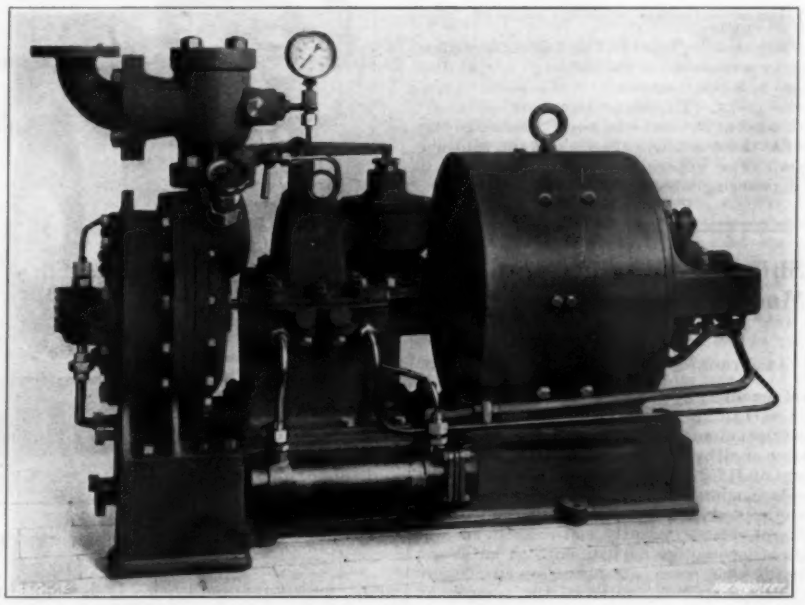


FIG. 75—13-KILOWATT SHIPS' LIGHTING SET—GREENWOOD AND BATLEY

and operated had a designed duty of 3 tons lifting capacity at 120ft. per minute, or 1½ tons at 240ft. per minute, with a light hook speed of 400ft. per minute. In addition to winches and deck auxiliaries, the firm displayed an all-electric steering gear equipment built on the Donkin-Scott principle, which has already been fully described in THE ENGINEER. Various types of motors and generators for ships' use were shown, including drip-proof, splash-proof and totally enclosed machines.

J. SAMUEL WHITE AND CO., LTD.

On the stand of J. Samuel White and Co., Ltd., of East Cowes, there was exhibited one of the firm's patented low-pressure oil-fuel burning installations. The apparatus on view comprised an oil-fuel pump complete with its strainers and filters, all mounted on a single bed-plate. Alongside there was a hinged furnace front complete with its burner, in which special provision is made for starting up with cold oil. When the burner has been lighted up, it is slightly rotated, and is then in the new position for hot oil burning. The firm also showed an ordinary type of furnace front fitted with a natural draught arrangement. Another exhibit comprised an electro-reversible pump, constructed under the Reed-Cooper patents, the pump and motor forming a single compact unit, which can be submerged to the desired depth. There were also on this stand several models of naval and mercantile ships constructed by the firm.

GLENIFFER MOTORS, LTD.

Gleniffer Motors, Ltd., of Anniesland, Glasgow, was represented by a comprehensive display of small marine motors, ranging from 7 horse-power up to a large emergency lighting set designed for an output

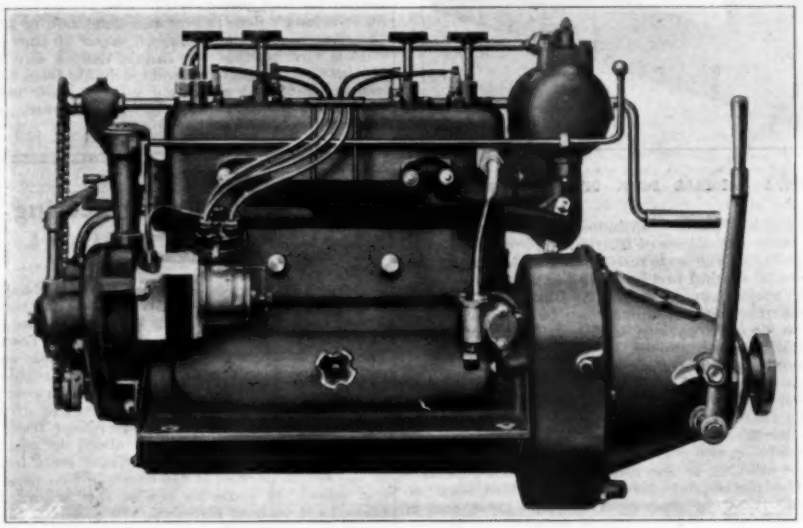


FIG. 76—14-16 B.H.P. FOUR-CYLINDER MARINE MOTOR—GLENIFFER

of 20 kW. The illustration—Fig. 76—shows one of a new Q series of engines recently put on the market by the firm with a cylinder bore of 3in. and a stroke of 4½in. The engine shown has a designed output of 14 B.H.P. on paraffin fuel and 16 B.H.P. on petrol. The recommended service speeds of the engine are from 900 to 1200 r.p.m. Units of the new Q type are built in two, four, and six-cylinder models, and, as shown, are fitted with totally enclosed reversing gears. If desired the reversing gear can be combined with a speed reduction gear. Our engraving serves to show the neat arrangement of the fly-wheel and reverse gear casing, and the ample sized inspection doors which give access to the running parts and the cam shaft. It will be seen that the cam shaft and the magneto and governor drives are of the geared type. Helical gear wheels are used, and an intermediate wheel of "fabroil" material ensures quiet running. A useful feature is the provision of a robust priming cock on the top of each cylinder fitted with a fibre hand wheel. The largest exhibit on this stand was a 20 kW six-cylinder oil engine generator set. The engine is coupled direct to a Crompton 220-volt generator, and is complete with a separate radiator equipped with a cooling fan. The bore and stroke of the cylinders are 4½in. by 5in., and it runs at a designed speed of 1000 r.p.m. The set will be installed on a South American passenger and cargo ship, which is now being built by William Beardmore and Co., Ltd., at Dalmuir.

THE SUNDERLAND FORGE AND ENGINEERING COMPANY, LTD.

The Sunderland Forge and Engineering Company, Ltd., of Sunderland and Belfast, showed an extensive range of ships' auxiliary machinery. There were examples of steam-driven generator sets, but by far the largest proportion of the exhibits was concerned with electrical auxiliaries, both for deck and engine-room use. We show in Fig. 77 a standard 3-ton cargo winch built by the firm. It is of the worm-geared type and the driving motor carries the control gear on the top, which is enclosed in a watertight box with the operating handle at the end facing the operator. Hand and foot-operated brakes are

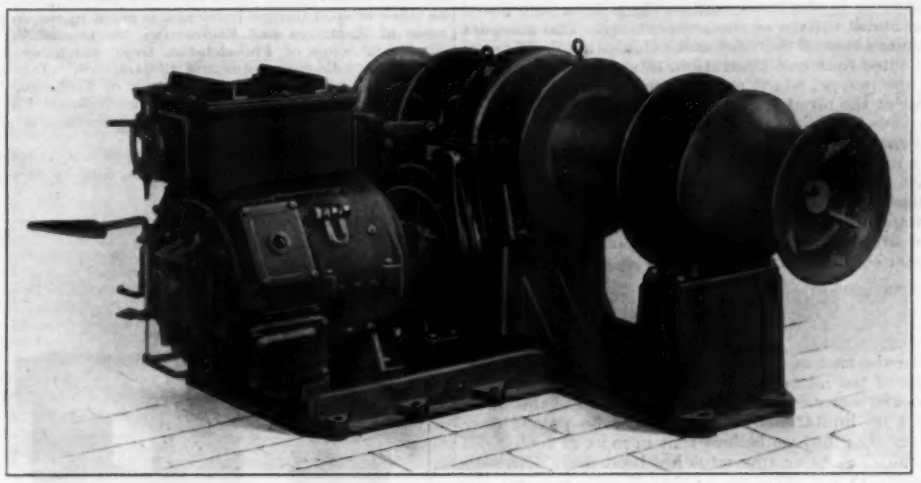


FIG. 77—3-TON ELECTRIC CARGO WINCH—SUNDERLAND FORGE

also fitted, and the operator is provided with a swinging seat. The contactor panels may be arranged either on deck or within a deck-house, and examples of various constructions were shown. The firm also exhibited lighting and navigation fittings and various types of motors and generators, specially designed to meet the requirements of marine service. An interesting exhibit—which we show in engraving Fig. 78—was the armature of a 210 kW direct-current generator specially designed for coupling direct to a Diesel oil engine. It is a fairly large armature, and has a core diameter of about 40in. The special feature of its design consists in the use of a stout steel spider of large diameter, into which the actual armature shaft is pressed. The resulting construction is a very robust one, which is specially suitable for oil engine work in which variable turning moments have sometimes to be dealt with. The other parts of the generator referred to were also on view, and we learn that this machine, which runs at a designed speed of 250 r.p.m., will be fitted on one of the oil engine lighting sets

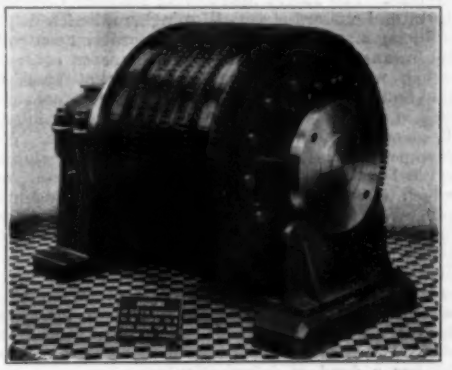


FIG. 78—GENERATOR ARMATURE—SUNDERLAND FORGE

which is to be installed in a vessel belonging to the British India Steam Navigation Company, Ltd.

THE ATLANTIC ENGINE COMPANY (1920), LTD.

The engines exhibited on the stand of the Atlantic Engine Company (1920), Ltd., of Atlantic Works, Wishaw, Scotland, embraced small and large marine motors, and also units for lighthouse service and for driving portable compressors. The compressor unit displayed on this stand was a No. 4 Reavell machine, similar to that which was described and illustrated in THE ENGINEER of July 29th. The engine we illustrate in Fig. 79 is one of the largest marine units

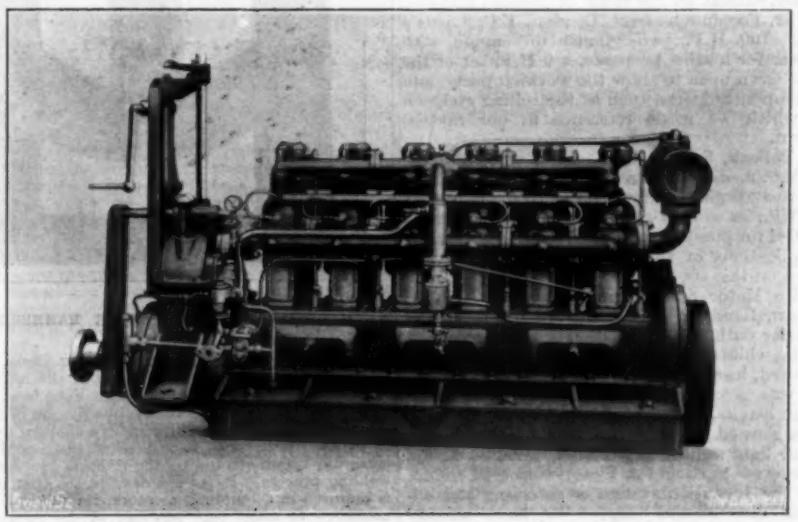


FIG. 79—48-54 B.H.P. SIX-CYLINDER MARINE MOTOR—ATLANTIC ENGINE CO.

constructed by the firm, and, as shown, an overhead type of control is fitted to it which allows the reversing operations to be carried out from the deck above that on which the engine is installed. It has a designed output of 48 B.H.P. on paraffin and 54 B.H.P. on

petrol when running at 900 r.p.m., and each cylinder has a bore of 5in. and a stroke of 6in. A feature of the piston design is the provision of a scraping ring on the skirt of the piston, which removes any excess lubricating oil from the cylinder walls, and discharges it below the piston through holes drilled in hollowed-out faces in the lower wall of the piston, just below the under surface of the scraper ring. The compact arrangement of the inlet and exhaust manifolds may be noted from our illustration, as well as the grouping of the pumps, which are mounted near the reversing gear at the forward end of the engine. The reversing movement is given by a rack and pinion motion, operated by a quadrant on the control lever. There is a main clutch fitted on to the end of the crank shaft with a gear wheel which meshes with a corresponding wheel on the intermediate shaft, and reversal is obtained by means of a roller chain. The engines are arranged for forced lubrication and the oil is water cooled in the crank case.

Conclusion.

In the case of an exhibition of this nature, and in view of the many interests which it represents, there must be many exhibits which, in a review of this kind, with its limitations of space, must be passed over hurriedly; but we believe that in most of such cases the machinery or apparatus has been dealt with previously in our columns, so that it only requires the mention of the firm's name to indicate to the reader the class of plant which was exhibited on the respective stands.

The case of E. Green and Co., of Wakefield, is typical; no engineer requires to be introduced to the firm's economisers, which were exhibited in the "tri-tube," the smooth tube, and the gilled tube designs. The Rapid Magnetting Machine Company, Ltd., of Lombard-street, Birmingham, had a display of lifting magnets and magnetic separators, controlled by means of the special potentiometer controller which we have already described, that gives the maximum magnetic flux with a minimum consumption of current. The Clews Petersen Piston Ring and Engineering Company, Ltd., of Mill-lane, West Hampstead, had a stand on which there were exhibited typical examples of the double-convolution rings which it manufactures by means of an ingenious process, explained before in THE ENGINEER, that ensures a tight fit between the adjacent faces of the two convolutions. Fry's Metal Foundries, Ltd., of Holland-street, Blackfriars, London, S.E. 1, had a stand displaying a great variety of white metal alloys and die castings; but the most interesting happening which fell to our lot on visiting the stand was a conversation with Mr. Mundey—he has a fund of information on alloys and their habits. Wailes Dove Bitumastic, Ltd., of Newcastle-on-Tyne, demonstrated the anti-corrosive qualities of its protective compositions, for use on ships' bottoms and such like purposes. It is noteworthy that this stand was "painted" with the firm's Bitumastic composition. The Standard Cork Company, Ltd., of 14, West Smithfield, London, E.C. 1, had a display of cork made up into a variety of forms for both engineering and domestic use. In the former case, naturally, the chief outlet is for the insulation of refrigerating apparatus. The granulated cork is compressed into the desired form and, on being baked, the natural glue it contains binds it together into a homogeneous mass. The shape is finally determined by machine planing. This material, it is claimed, will stand a test of three hours' boiling without disintegration.

The main exhibit on the stand of Perman and Co., Ltd., of 82, Fenchurch-street, London, E.C. 3, was a Kromhout 100 H.P. two-cylinder oil engine with reverse gear for marine purposes, a 9 H.P. set of the same type sawn open to show the working parts, and several component parts, such as the rolling gudgeon pin, to which we made reference in our Special Supplement.

James Pollock, Sons and Co., Ltd., of 3, Lloyd's-avenue, E.C. 3, displayed a two-cylinder marine oil engine of the "Bolinder" type, designed for an output of 90 B.H.P., as well as smaller engines of the same type applied for pumping work and for winch driving. Some applications of the Star Contra rudder were also shown on this stand.

The Elto Motor Sales Company, of 150, Southampton-row, London, W.C. 1, showed the new 1927 twin-cylinder outboard model designed for an output of 4 B.H.P., while a new four-cylinder 8 B.H.P. engine was exhibited, installed in a racing skimmer.

There was a comprehensive display by Welin-Maclachlan Davits, Ltd., of 5, Lloyd's-avenue, E.C. 3, which firm showed models of gravity davits, quadrant davits, and light semi-rotary davits. Walter Kidde and Co., of New York and 2, Victoria-street, London, exhibited the Lux-Rich system of detecting and extinguishing fires aboard ship. We have already described in the columns of THE ENGINEER the Rich smoke-detecting cabinet, which has now been arranged to work with a battery of CO_2 cylinders, so that the gas can be discharged through the smoke detector pipes and the hold effectively flooded with dry CO_2 gas. The same CO_2 system is shown as applied to various marine craft and also for industrial installations.

Arc-Welded Connections for Steel Structures.

An account of some interesting experiments on the strength of arc-welded joints for structural members, such as those of steel-framed buildings, is given in the August issue of *Engineers and Engineering*, the journal of the Engineers' Club of Philadelphia, from which we have culled the following notes and illustrations. The tests were made at the Carnegie Institute of Technology on work principally prepared by the Westinghouse Electric and Manufacturing Company, and the account is given by Mr. A. M. Candy.

In his opening remarks the author says that he believes that lines of beams, or lines of girders, can, by means of

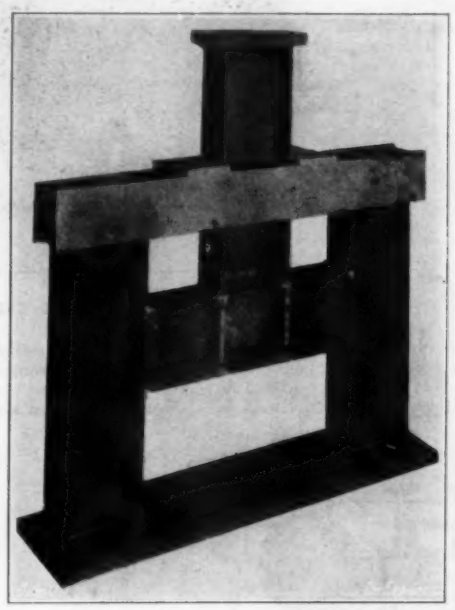


FIG. 1—ORIGINAL FORM OF TEST PIECE

arc-welding, be made continuous throughout their supports, while the degree of fixation thus provided gives such a rigidity to the structure as to enable a reduction in the amount of wind bracing required, so that as much as, or even more than, 10 per cent. of the steel normally used in constructing a building may be eliminated. In addition to possible savings in labour and material in construction, welding should, to a certain extent, help to minimise the problem of corrosion, as a welded structure would be easier to paint. In the case of the welded structure, the corners of the joists are radiused out by the weld fillet, while there are no rivet heads to work round with the paint brush. Also in the case of several layers of metal overlapping the edges of the joints could be closed by a film of welding, so that moisture could not penetrate between the plates and cause rusting. (Had such an art been developed a generation ago, the great cost of

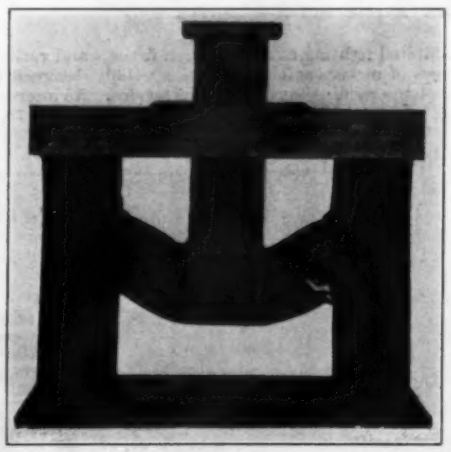


FIG. 2—TEST PIECE AFTER HAMMERING

strengthening the Hungerford, Charing Cross, Bridge in London, on account of the bulging of the multiple plate ties, through internal rusting, might have been obviated.)

But Mr. Candy thinks that probably one of the biggest advantages of welding will be where changes are required in existing structures, regardless of whether those structures have been erected by the riveting process or by the welding process. It is very easy to see that if a change is required in a building, or room, for example, it is only necessary to make bare one face of the column, set the essential members in place and weld around the ends, whereas in riveting it is necessary to get at the back of the column in order to back up the rivets in closing them.

It would occupy too much of our space to detail all the tests described in our contemporary, but the two of which we reproduce the illustrations serve to substantiate the contention that the welds are stronger than is necessary to develop the full strength of the members.

A specimen test piece was built up—as shown in Fig. 1—using a 6in. 12½ lb. joist measuring 18in. long for the principal member. This specimen was placed under a large steam hammer and struck a number of blows and was deflected 3in. before it failed—as shown in Fig. 2—where, it will be noticed, both the breakages are outside the welds. A similar specimen was placed in a hydraulic press and was distorted to the form shown in Fig. 3, without complete failure, at a load of 100 tons, but the ram member, it will be noticed, collapsed.

In order to make a comparative test two more specimens were built up, one by welding and the other with the usual system of rivets and angle plates. The welded specimen

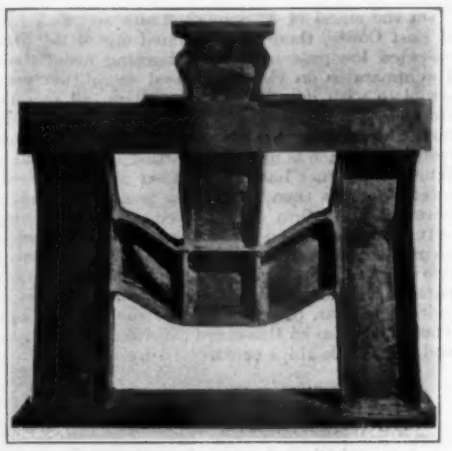


FIG. 3—TEST PIECE AFTER PRESSING

required 1½ lb. of welding metal, while the riveted one needed 15 lb. of added metal. The welded beam withstood 90 tons load before failure at a deflection of 3in., whereas the riveted specimen collapsed under 60 tons load.

It is obvious that one cannot deduce any formulæ for the intrinsic strength of welded joints from these experiments; but they go a long way to show that properly made they may be superior to the usual system of riveting.

South African Engineering Notes.

"Hulse" Double-decked Coach.

One "Hulse" double-decked railway coach has been completed at the Salt River Works and has been given a trial run. This vehicle has been finished as a third-class coach for experimental use on the Cape Town suburban line, and as it is understood that the trials were entirely satisfactory, it will no doubt be put into regular use at an early date. The main dimensions of the coach are practically the same as those of the latest imported type, but the accommodation has been increased from 88 to 124 in the "Hulse" coach, or by about 40 per cent. This increase has been effected by fixing seats longitudinally in the centre portion of the coach in two tiers, one above the other. In order to enable this arrangement to be carried out without increasing the height of the top of the coach from rail level, as compared with the latest standard coaches, the floor of the centre portion of the coach has been lowered so as to give a minimum clearance of only 6in. between the underside of the frame and rail level. The seating accommodation is made up as follows:—Ends of the coach over bogies, 28 persons; upper tier, 48 persons; lower tier, 48 persons; total, 124 persons. Entrances are provided over each bogie, from which an intending passenger is able to see at a glance the accommodation available on either tier of seats, while the arrangement of the latter is such that the entering and leaving of passengers causes a minimum of inconvenience to other occupants of the coach.

Rhodesian Railway Workshops.

The principal locomotive and rolling stock erection and repair works of the Beira and Mashonaland and Rhodesia Railways are situated at Bulawayo (Southern Rhodesia), and there are other shops at Umtali on the border of Mozambique territory. The Bulawayo shops are equipped with all the latest and most up-to-date machinery for undertaking all descriptions of railway erection and repair work, and they are of special interest owing to the situation being so far inland. The existence of these workshops became possible, on their present scale, only when the Khami River was dammed some eleven miles outside Bulawayo, and a plentiful supply of water was assured. The workshop buildings cost £80,000, and a further £140,000 was incurred in providing plant and equipment. The shops, which give employment to some 320 Europeans and 350 natives, cover an area of over twenty acres with land up to 70 acres available for extension purposes.

Very extensive repairs to locomotives can be effected. On the writer going over the shops at the end of July, he found the equipment for electrical cutting of plates and for welding to be at least the equal of any in the sub-Continent, while the machines for turning up wheel tires and reboring wheel bosses, &c., are probably unequalled in Africa. The foundry is capable of turning out castings of a very respectable size, and, of course, all white metal and other bearings are made there. In the carriage shops coaches are practically rebuilt, and the very latest varnishing appliances are installed (seven coats are given). So rapidly are the railway demands increasing that at present some of the shops are being increased 100 per cent. in capacity, and the remainder of the shops by 50 per cent. Some portion of the increase must, however, be conceded to be due to the intention—so the writer was informed—

of the Administration to concentrate most of the heavy repairs, &c., at Bulawayo and to reduce the establishment at Umtali, where only minor running repairs will then be executed.

The total mileage of the B.M. and M.R.R. is 2462, the gauge being 3ft. 6in., and the rails 60 lb. per yard. The engine power of the railways at present is 161 locomotives, in which are included 12 Garratt engines and 20 twelfth class mountain type; there are 30 each of seventh and ninth class. With the increasing demands of traffic and improved permanent way it has been possible to increase continually the size and power of the locomotives purchased and in this connection it may be mentioned that the tractive force of the Garratt engines is 34,560 lb. as compared with 18,660 lb. in the case of the seventh class engines. The goods stock consists of something like 2700 vehicles, and every class of traffic is adequately provided for. The carrying capacity of the trucks used varies from 15 tons to 45 tons. The coaching stock of the railway consists of 164 coaches, including 31 private saloons, service coaches, &c., 9 dining cars, and 75 passenger saloons and composite carriages.

The names of the members of the Rhodesian Railway Commission, of which Sir William Hoy, K.C.B. (who is just relinquishing the general managership of the South African Railways) has accepted the chairmanship, have recently been announced, and the Commission is expected to work immediately under the *pro tem.* chairmanship of Mr. E. H. Hiley, who was until comparatively recently general manager of the New Zealand railways. The member chosen to represent the interests of Southern Rhodesia is Mr. J. R. Fulton, who was lately of the South African Railways and Harbours Administration, where he held an important post. The representative of Northern Rhodesia is Mr. R. Goode, C.M.G., recently chief secretary of the territory, and who is at present the Acting Governor. The Bechuanaland representative is Mr. A. Warren, the accountant for the Protectorate, Basutoland and Swaziland. It will be realised that Sir William Hoy will preside over a Commission of experts, who have achieved eminence in varying spheres. With the long experience and extensive knowledge of Sir William Hoy, backed up by the expert technical qualifications of Mr. Fulton, and counterbalanced by the official administrative and financial experience of the Northern Rhodesian and Bechuanaland representatives, it is thought that the Commission should have no difficulty in grappling with the problems which are already awaiting its consideration. Mr. R. Drage, who has been appointed secretary to the Commission, has had varied and extended secretarial experience in railway matters, and is said to be particularly *au fait* with the provisions of the English Railway Act.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

More Hopeful Tone.

THIS week has witnessed more movement in the Midland iron and steel market than has been the case for some months, and on 'Change in Birmingham to-day—Thursday—the market tone was decidedly more hopeful. The attendance was larger than for some weeks past, and though there was not a sufficiently large expansion of demand to justify the belief that a reinvigoration of trade was imminent, there were inquiries circulating and movements in the raw iron department which had a cheering effect upon producers and resulted in a better general market tone. In some quarters the progress, slight as it was, was hailed as the commencement of the autumn revival. It was held that consumers of iron and steel have waited as long as possible, and must now get supplies if the works are to be kept active. It was even claimed that in some cases users of iron and steel were booking into next year, having satisfied themselves that prices have touched bottom, and that nothing is to be gained by waiting. Another week or so will show whether the optimism is justified.

Pig Iron Improvement.

The most noticeable feature of the market this week has been the additional improvement in and strength of the pig iron department. Many consumers having exhausted their stocks have been urgently in need of supplies, and the satisfying of these demands has almost entirely cleared stocks at the furnaces. Indeed, sales of foundry iron are said to have gone ahead of current production. While this is probably true, it has to be remembered that nine blast-furnaces were closed down last month. Decreased supplies may have had more to do with turning the balance than increased consumption. There is a growing belief that at last the market is on the mend, and it is thought that pig iron will lead the way in the new market movement. As yet there are insufficient grounds to justify a too optimistic view of the situation, but it is worthy of note that this week individual furnacemen in Derbyshire are testing the susceptibility of the market to face an upward price movement. Business is still too precarious, however, for any but exceptionally well-placed firms to attempt anything of this sort. It is quite evident that the "bearing" tactics of merchants have been outstayed, and that the control is going into producers' hands. Although stocks at the furnaces are now almost at an end, there is no difficulty as yet in getting prompt supplies, but if the demand continues to increase, as it is hoped it will, then it seems likely that production will have to be increased. At the current rate of consumption, however, there is a substantial margin of safety, and buyers are not showing any nervousness. Foundry pig iron prices are, under the circumstances, firmly maintained. Derbyshire and North Staffordshire No. 3 command £3 5s., Northamptonshire £3 0s. 6d., Cleveland is £3 7s. 6d. Quotations for mixed numbers of East Coast hematite are round £3 13s. In pig iron continental makers are no longer competitors, their prices being at least 2s. a ton more than those of native makers. A little interest was this week displayed in forge irons. Inquiries were on the market as to a fairly large tonnage of forge pig, and smelters were said to be willing to concede something on the quotations of £2 14s. to £2 15s., but they would not go far enough to secure the business.

Steel.

There are no signs as yet of a fresh impetus in the steel department of the market. Some progress has been made with the rebate scheme, to which consumers are now taking somewhat more kindly. It will be impossible for some months to get even an idea of what business is being done under the scheme, since no claim can be made and no information given until the consumers apply for their rebates, on the representation that they have bought no foreign steel. It is generally understood, however, that the steel works are rather busier. The important advantage of quick deliveries is said to be weighing very much in local makers' favour just now, since buying has been so restricted that many consumers have no stocks, and orders for continental material must take some time to execute. Selling is extremely keen. Native steel prices are practically unchanged; if anything, the tendency is for values to ascend. Angles and joists are £7 12s. 6d. less rebate, and tees £8 12s. 6d. There would appear to be some ground for the recent announcement that continental competitors are becoming alarmed. They are certainly sending into the Midlands some very low quotations. One firm recently received price lists from five different exporters; the lowest was £4 13s. for steel joists to the British standard test of 28–32 tons tensile. This seems to be the lowest figure, and it indicates that foreign joists can be bought here at £6 delivered, or about £1 10s. below the English figure, after the rebate has been conceded. Plates are in much the same category, being offered at £6 2s. against the English price of £8 7s. 6d. Welsh billets are now procurable at something less than £6 10s., but most local producers adhere to this quotation. Small bars are maintained at £7 15s. upwards. Foreign steel strip for tube making can be bought at £6 2s. 6d. per ton, against the English very low price of £7 15s. Germany is sending in large quantities of this material. Scrap is nearly unsaleable, even at £2 17s. 6d. delivered South Wales. Large quantities of steel turnings are selling at £2 10s. delivered.

Finished Iron.

The iron trade remains in a very depressed condition. Many of the forges and mills are unable to run more than half time, and prices are being severely cut. Lancashire bar mills are keen competitors for the trade. They are accepting prices lower than those which are considered profitable by Staffordshire makers, but the latter do not admit that the qualities are comparable. Many local mills continue to quote Crown bars at £10 per ton, but it is claimed that they will accept less to secure business. Similarly, nut and bolt and fencing bars of Staffordshire make are quoted £9 5s., but a good order could be put through at £9. There is very little business for anyone, however, and the outlook for this side of the iron trade is far from encouraging. As regards best marked bars, the situation is somewhat better. Here there is neither competition from other districts nor from abroad, and makers are getting a fair number of orders, though nothing like sufficient to find them full employment. Values are maintained at £13 10s., and it is not anticipated that there will be any readjustment in the near future. Wrought iron gas tube strip prices are hardly maintained, and considerable shading of last week's quotation of £11 17s. 6d. was to-day reported. Some consumers claimed to be able to get supplies at as low as £11 12s. 6d., but sellers generally were not prepared to accept business at this figure.

Galvanised Sheet Values.

Galvanised sheet prices have fallen further, 24 gauge corrugateds being pretty generally quoted on 'Change in Birmingham to-day—Thursday—at £13 17s. 6d. —fully half a crown below last week's figures. Those mills which a week ago asked £14 2s. 6d. for their production are now willing to accept £14. The bulk of the business transacted, however, is now on the basis of £13 17s. 6d. f.o.b.

Flint Glass Trade.

Continued improvement in the flint glass trade in the Birmingham and Stourbridge districts is reported. The industry has not as yet overcome the difficulties which beset it, but the man-power of the industry is not being wasted as it was some time ago. The new life which has been infused into the glass-houses of this district is, no doubt, primarily attributable to the seasonal demand. Stocks are being replenished in the wholesale and retail channels, so that the manufacturers can confidently go ahead with their production programmes. There is more activity in the medium-glass trade, and utility goods, as well as those which depend upon their artistic appeal, and the portents are in other respects more encouraging.

No Beet Factory for Hereford.

After reconsidering their decision not to build a beet sugar factory at Hereford owing to the opposition set up by anglers, who maintained that the effluent would poison the fish in the Wye, the directors of British Sugar Developments, Ltd., have announced their final abandonment of the scheme.

Another Beet Factory Scheme.

I learn that negotiations have been commenced by a beet sugar syndicate for acquiring a site in the Lichfield and Tamworth district with a view to the erection of a beet sugar factory. The site selected is in the midst of an area eminently suitable for the cultivation of beet sugar, and it is understood that early steps will be taken to enlist local agricultural and financial support for the scheme.

Unemployment.

The latest returns show a further decrease in the number of unemployed in the Midlands, the figures having fallen from 139,237 to 132,139. The total, which is 11,895 smaller than a fortnight ago, is made up of 95,348 men, 3396 boys, 29,517 women, and 3918 girls. In the Birmingham area a further decrease of 1255 has brought the total down to 26,114, but even this figure is 100 higher than that recorded three weeks ago. At Coventry also there has been another fall on the week, the total unemployed now being 6690, against 7217 a week ago and 7699 a fortnight ago. Decreases are reported in all the Black Country towns, with the exception of Cradley Heath and Smethwick.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

The Railway Carnival.

THE third Railway Carnival, held at Belle Vue, Manchester, last week-end, was not the entire success which its promoters had a right to expect. This, however, was due wholly to the miserable weather conditions. In spite of this, it is estimated that some 45,000 railway employees were present. This year's event was on a larger scale than either of its two predecessors, and with its special revue "Excursions," its pageantry, its sports and parades, had all the elements that make a carnival go with a swing. The underlying object of those who were responsible for the carnival idea is the improvement of relations between employers and employed in the railway world. As usual, there was a gathering on a large scale of railway workers in the Belle Vue ballroom. This meeting was addressed by leaders on both sides, the speakers on the present occasion including Sir Ralph Wedgwood, Sir Edwin Stockton, Mr. J. H. Thomas, Mr. J. Bromley, and Mr. A. G. Walkden. The keynote of all the various speeches was the fostering of the spirit of goodwill between railway managements and men.

Textile Machinery for the Continent.

There has been no actual development in the reported £20,000,000 credit scheme for financing the export of textile machinery to Germany, and although there has been much public discussion in the Press in the interim, the position remains virtually as it was outlined in this column a week ago. Apart from the question of finance there are certain fundamental and practical difficulties to be overcome before the manufacture of plant in this country for export to the Continent on the scale envisaged by the scheme can be regarded as a practicable proposition. Meanwhile, the much-debated question of the Russian market for textile machinery has become prominent again by the reports this week that substantial contracts for Russia have been placed with the Rochdale firm of Tweedale and Smalley, Ltd. There is no official confirmation at the time of writing, but it may be recalled that negotiations between the Russian Textile Syndicate and the firm in question were in progress at the time of the diplomatic rupture between this country and Russia some months ago.

A Twenty-year Task Completed.

A reservoir which has been in process of construction by the Manchester Corporation since 1907 is approaching completion, and its official opening is expected shortly. The work was commenced in 1907 by G. H. Hill and Son, engineers, of Manchester, but was suspended during the war as the result of the conditions then prevailing. The agreement between the Corporation and Messrs. Hill expired in 1917. Five years later, under the direction of Mr. L. Holme Lewis, the city waterworks engineer, the work was resumed by direct labour, and, as stated above, is now nearly completed. The reservoir is situated in Heaton Park, on the northern outskirts of the city, and has a capacity of 560,000,000 gallons of water.

Bury's £99,000 Electricity Scheme.

Bury Corporation has received the formal sanction of the Electricity Commissioners to the extension of the Chamber Hall electricity generating station. The estimated cost of the scheme is £99,000.

Cables Again.

As a result, it is said, of the great difference between the prices quoted in tenders by British and foreign firms for the supply of high and low-tension electric cables, the Electricity Committee of the Warrington Town Council has instructed the electrical engineer to buy cables from one of the British firms for a period of three months only at schedules prices. In the meantime, the electrical engineer has been instructed to inquire into the reasons for the high prices of British tenderers and to report to his Committee.

Non-ferrous Metals.

If it has not actually broken something closely resembling a "break" has occurred in the tin market during the past week, and, as has been evident for some weeks now, the expectations of the "bulls" have been sadly disappointed. Current values are the lowest touched during the past sixteen months. Six months ago, in the last week of March to be exact, cash metal was as high as £315; to-day it is roughly £50 less than this. Since the beginning of August, when the quotation was in the neighbourhood of £300, the decline has been steady and almost continuous, with prices at the time of writing at about £266. Brought down to essentials, it has been merely a question of supply and demand. The high prices that were ruling when supplies were scarce brought into operation fresh sources, and with the industrial demand at a low ebb the market has had to give way. With users of other non-ferrous metals maintaining a cautious attitude,

values have declined all round, more particularly in the case of lead, of which latterly there had been hopes of recovery. Relatively, spelter has been least affected, but the decline in copper compared with a week ago has been fairly substantial.

Iron.

The tone of the iron and steel markets continues to brighten, although improvement in actual business is a slow process. There is no doubt, however, more especially in the case of foundry iron, that the state of trade at the moment is appreciably better than it was several months ago, when the market was in the depth of the depression. Makers offering on the Lancashire market have fully maintained the prices that have been ruling during the last few weeks, and buying confidence is growing in consequence. This is reflected in the occasional orders that are being booked for delivery to the end of the year, and in some instances to the end of January. Buying for two or three months forward is relatively more frequent. The improvement is by no means sufficient at this stage to justify starting more furnaces, but it is in most cases sufficient to prevent stocks accumulating, which in itself is a not unfavourable factor. For delivery into the Manchester district, Staffordshire makers are quoting from 73s. to 73s. 9d. per ton, Derbyshire about 73s., Middlesbrough 80s. 8d., and Scottish, 91s. to 91s. 6d., with hematite selling at about 87s. Only a quiet trade is being done in manufactured iron, but Lancashire Crown bars are unchanged at £10 per ton, with second quality on offer at £9 10s.

Steel.

A moderate demand for joists and sections, principally for constructional engineers, has been reported this week, largely for near deliveries, but for other varieties—locomotive and ship and general plates and steel bars—inquiry has been on a limited scale. There has been no important changes in price levels during the week, boiler plates being offered at £10 15s. to £11; tank plates at £8 7s. 6d.; joists and sections at £7 12s. 6d.; and steel bars at from £7 15s. to £8 10s. per ton, according to quantity. In the case of imported steel materials, there has been rather more inquiry, and a slight increase in the actual amount of business put through. Instead, however, of prices steadying up a little, the keen competition between the merchants and continental makers on this market has had the effect of weakening values, more especially so in the case of billets and sheet bars. These materials are now quoted at £4 18s. 6d. and £5 2s. per ton respectively, for delivery to Lancashire works, for cash against documents, whilst sections are at £5 13s.; Siemens plates at £7 10s.; ordinary plates at £7 2s. 6d.; steel bars at £5 12s. 6d.; wire rods at £6 7s. 6d.; and bar iron at £5 14s. The Indian and other Eastern markets are paying little attention to galvanised sheets just now, and 24-gauges are nominal at about £13 15s. per ton f.o.b., although the tendency is undoubtedly weak.

Institution of Mechanical Engineers.

A large party of members of the North-Western Branch of the Institution of Mechanical Engineers paid a visit of inspection to the Crewe Locomotive Works of the London, Midland and Scottish Railway Company on Wednesday, 21st inst. As is generally known, these works have been completely reorganised during the past few years, and all departments have been brought up to a high state of efficiency. Captain Beames and his assistants conducted the members round the various departments, including the new boiler building shops, where the construction of boilers from the plates to the finished product was seen; the drop hammer plant, which has been brought up to date; the new steel furnaces, both acid and basic, where 80,000 tons of steel per annum can be produced; the heavy machine shop where the erection of locomotive frames was witnessed; the tube shops, where the repairs of flue and smoke tubes are carried out in a remarkably expeditious manner; the reorganised machine shop; the foundry; tender shop, brass-finishing and paint shops; and the new erecting shop equipped with the belt system of repairing and overhauling locomotives. It was explained that by the new belt system it is now possible to strip, overhaul and repair locomotives in a period of twelve days, a feat which is not accomplished in any other locomotive works in the world. At the conclusion of the inspection of the works a vote of thanks to the directors of the company, Captain Beames and his staff was proposed by the chairman of the Branch, Mr. H. F. Massey, and was seconded by Mr. Cecil Bentham. Captain Beames replied to the vote of thanks, and said the visit of the Branch had been a source of pleasure to him and his staff.

BARROW-IN-FURNESS.

Hematite.

The hematite pig iron market is quiet. This condition has now obtained over a rather lengthy period. But for the fact that the steel departments are taking large deliveries of iron there would be, no doubt in the view of the state of the market, a restriction in output. Up to the present, the reduction in prices has not tempted larger orders or important orders for forward delivery. Customers still prefer to buy for immediate requirements only. The iron ore trade is naturally affected by the restricted number of furnaces in blast in the district, and there is less activity at the mines than formerly. Foreign ore is being brought in in reduced quantities. The steel trade is fairly well employed at the moment, and there is every reason to expect that most departments at Barrow will continue employed over this year. The hoop mills are assured of a steady run.

Shipbuilding.

There was launched on Tuesday from the yard of Vickers Ltd. the twin-screw steamer Orford, which has been built to the order of the Orient Steam Navigation Company. The Orford is the third of its type to be built by Vickers, the two previous vessels being the Orama and the Otranto. They are large steamers, approximately of 20,000 tons displacement, and with a similar horsepower. The speed is about 19½ knots. The launching ceremony was performed by Lady Ryrie, wife of the chief Commissioner of Australia. It was stated during some speeches which followed the launching ceremony that the Orient Line was inviting tenders for another and slightly larger steamer.

SHEFFIELD.

(From our own Correspondent.)

Another Furnace Shut Down.

TRADE in ordinary heavy steels is remarkably quiet and of late orders have tapered off to an extent which has forced the putting out of commission of another open-hearth furnace. Users of billets continue to be satisfied with what are virtually day-to-day supplies. This careful buying is made necessary, not only by the depressed state of trade, but by financial stringency. The recent reductions in the prices of steel have made no difference. For example, there is no more buying of hard basic billets now than there was before the official minimum was reduced, which means that the makers are having to stand the whole loss of their concession. A similar comment is applicable to bar iron, the reduction here also having had no influence as an incentive to greater buying. All this, of course, indicates that users are accepting minimum deliveries, and the immediate prospects appear to be such as not to encourage any developments. Possibly there is a little more confidence in the market for pig iron, shown by the fact that a few forward contracts have been placed, but the general policy here, too, is to purchase in just sufficient quantities to cover immediate requirements. In the case of practically all other classes of raw material, quotations tend to become easier. Scrap has moved down in sympathy with the general trend, and as a result of the falling demand for export purposes, and ferro-alloys are for the most part in a depressed state.

Lighter Steel and Goods.

Fortunately, the dull condition in the heavy trades is partly counteracted by a brighter state of things in the lighter departments. There is, for example, a fair rate of business coming through for the smaller steel castings, and certain classes of machinery and tools are maintaining fair order books. Specialist lines are the busiest, and in certain branches of engineering work the world over it has been found that Sheffield firms, by their concentrated attention to quality, can provide steel and steel parts of a quality that no other rival producing centre can touch. In files, saws and most classes of edge tools there is keen competition to get business, and with more material being offered than there are orders to go round, plants are running short of capacity and prices are being severely cut. For drill steel there is a good sale abroad, particularly in the South African mining areas, and the prospects are reported to be good. It is difficult to find anything of outstanding interest to report in the cutlery and plate industries. These, it is true, have got somewhat out of the rut into which they declined early in the year, but they are still a good way below the position they should occupy at the opening of autumn. The general position has been improved by the placing of a number of useful orders by shipping and other companies with large catering interests, but as yet there is no great volume of business coming through the shopkeeping channels. The output of stainless steel cutlery is considerable, but, nevertheless, it is a long way from being enough.

Army Safety Razor Contract.

A year ago, it will be recalled, the Government came in for severe criticism because it gave the first British Army contract for safety razors and blades to the Gillette company of America, without inviting British firms to tender. The time having come for the contract to be renewed, it has again been placed with the same company, but on this occasion tenders were invited. Sheffield people were inclined to protest against the contract going to this American company again, but an official of the Government Department concerned was not inclined to be very sympathetic. "The facts are simply these," he explained: "The War Office invited thirty-six British firms to tender against Gillettes. Only twenty firms availed themselves of the opportunity, and not one of them quoted a price comparable with that asked by the Gillette firm. That is the beginning and the end of the story. Sheffield, in common with other parts of the country, was beaten in fair and open competition, and has no grounds for complaint. Incidentally, it is quite incorrect to say that the British Army razors are being made in the United States. All the blades supplied to us will be made in Montreal, Canada." As a matter of fact, about twelve firms in Sheffield and district were invited to tender.

Colliery Hauling Appliances.

A number of new haulage appliances for collieries have recently been introduced by Hadfields, Ltd., of Sheffield, these including a dustproof tub, an anti-friction self-aligning pedestal, and a runaway tub catch. This last device is particularly interesting. It is designed for automatically stopping on an incline tubs which have got out of control. It consists of a strong steel frame supporting two steel rocking levers, which project in a slantwise position adjacent to each other. When a tub passes over the appliance at normal speed the two levers are merely depressed, but if the tub should exceed a speed of approximately 4 miles per hour, the lever nearest the oncoming tub is thrown completely over by the front axle, thereby preventing progress of the tub. The dustproof tub, another of the new appliances, has a body built of steel plates fitted together by means of bolts and nuts. The sides and end plates are turned over on the top edge, which adds to the strength and makes the tub extremely rigid. The new pedestal is an open one, formed with three convex bearing surfaces at right angles to each other instead of the usual semi-circular form of bearing. It is claimed by this means that the pedestal tends to polish, rather than to wear and to cut the axle. In case of violent collision, or forcible stoppages against the tub stops, there is less risk of the guard being broken, since, owing to the shape of the bearing, the vertical face receives the thrust of the axle instead of the guard.

Colliery Topics.

Several interesting references to its colliery undertakings were made by Lord Aberconway at the annual meeting in Sheffield of the Sheepbridge Coal and Iron Company, Ltd. The low vein at Glapwell is making good progress, and nearly 1000 tons of coal a day are being got from that pit. The new pit at Blidworth is being developed and the coal is proving of good quality. The Firbeck Colliery also is producing a satisfactory output, but progress has been restricted by the state of trade. The company, by the way, have written off the expenditure connected with the Finningley coalfield. The opinion was formed that it was useless to expend any further money to develop that property. It is announced that Babbington Colliery Company, owners of a group of five important pits in Nottinghamshire, have purchased Sansoms Wood Farm, an estate of 400 acres on the road from Nottingham to Ollerton, with a view to pit sinking. To provide capital required to meet the growth of the company's business the directors of the Nunnery Colliery, Ltd., Sheffield, have decided to issue the remaining 30,000 unissued ordinary shares of £1 each at par.

Junior Chamber of Commerce.

In order to stimulate the young men of Sheffield to take a prominent part in the public activities of that city, it has been decided to form a Junior Chamber of Commerce. The scheme has been prepared by the senior organisation.

Construction of a Large Dam.

When the members of Bradford City Council paid a visit to the dam being built at Pateley Bridge, which it is said will be one of the biggest dams in Europe, they saw a scheme which involves the employment of 700 men, fifteen locomotives, twenty locomotive cranes and two steam navvies. The large dam is being formed by the construction of a cyclopean masonry wall, 1800ft. long, with a maximum height of 257ft. and 135ft. thick at the foot. It will contain 750,000 yards of concrete and masonry. The reservoir will be 154ft. deep.

NORTH OF ENGLAND.

(From our own Correspondent.)

Shipbuilding Activity.

THE outstanding feature in North of England trade circles this week has been the placing of a number of contracts for new vessels with North-East Coast shipbuilders. Altogether orders for six vessels have been given out by Sir Robert Ropner and Co., Ltd., West Hartlepool, and all are of the cargo type. Two will be built by the Cowpen Shipbuilding and Dry Dock Company, Ltd., Blyth; two by Smith's Dock Company, Ltd., South Bank; one by Sir James Laing and Co., Ltd., Sunderland; and one by William Gray and Co., Ltd., West Hartlepool. With these six new orders Sir R. Ropner and Co. have now building or on order fourteen steamers, the first of which is to be launched in November and the last in October next year. The vessels just ordered will be about 9000 tons deadweight. The two 11,000-ton twin-screw insulated vessels placed with Tyne builders by the Commonwealth and Dominion Line for their Australian trade are to be fitted with the Doxford opposed-piston oil engines, which are to be built by Wm. Doxford and Sons, Ltd., at their Pallion Works. They are to be of the four-cylinder balanced type with bore of 600 mm., and combined stroke of 2320, together giving 8000 B.H.P.

Cleveland Iron Trade.

Slow but steady progress in the direction of revival continues in the Cleveland pig iron trade. A rather more rapid increase in demand would be welcomed by ironmasters, but hope is expressed that nothing in the nature of a boom will occur to disturb and possibly shatter genuine trade development. The present demand necessitates withdrawals from makers' stocks, and there is a possibility of more blast-furnaces being put into operation. Export inquiry is brisk, shipments are showing a substantial advance, and more and more iron is being taken up by local users and by firms in Scotland. The announcement of a reduction in the home price of French pig iron is not unwelcome if it implies an increase on export prices. The change closely follows one made by German producers. In the case of France, however, the decision only aggravates an anomaly which shows Britain exporting iron to France at some shillings below production cost, and France exporting to Britain at even higher sacrifices. It is a position which, from the maker's viewpoint, demands adjustment. Meanwhile the reported cut in the home price of French iron raises anew the problem of the disparity in British import and export prices. Cleveland pig iron prices are firmly maintained, No. 1 foundry being 70s.; No. 3 G.M.B., 67s. 6d.; No. 4 foundry, 66s. 6d.; and No. 4 forge, 66s., for home purposes. Makers' fixed prices for dispatch to Scotland and to foreign destinations are 2s. 6d. below the foregoing quotations.

Hematite Pig Iron.

The East Coast hematite pig iron trade shows little change. Stocks are falling, but are still heavy, and producers are keen sellers on the basis of 75s. for mixed numbers, and 75s. 6d. for No. 1 quality, both to home and overseas buyers.

Ironmaking Materials.

Delayed deliveries of foreign ore against old contracts are rather considerable, and consumers' storing accommodation is fairly well occupied. Merchants report occasional inquiries, but consumers are not disposed to

pay rates asked, which are based on best Rubio ore at 21s. per ton c.i.f. Tees. Notwithstanding the declaration of Durham blast-furnace coke producers that, rather than reduce current unprofitable quotations they will put ovens out of operation, users persist in seeking price concessions and are buying very cautiously. Good medium descriptions are on offer at 18s. per ton delivered at the works.

Manufactured Iron and Steel.

Finished iron prices are steady, and manufacturers are turning out a lot of work. Steelmakers are also producing heavy tonnage. New orders are not plentiful in either branch, but a few fairly good contracts for structural material are reported to have been arranged. Increased activity at the shipyards is bringing in a few orders.

The Coal Trade.

The Northern coal trade is without any special feature of encouragement, and the general tone of the market is one of dullness, with a tendency to a further ease in prices. The demand has not yet come up to expectations, but seasonal requirements may soon help the situation. The securing of one of the private Swedish railway orders for 20,000 tons of best Wear steams by Newcastle merchants has come as a surprise, as it had been generally expected that the contract would go to Silesia. Moreover, the contract has been secured at a price which is nearer to current values than some recent business has been. Other orders are pending, including two cargoes of steam coal for the Norwegian State Railways. For trade of this kind the Silesian shippers are very keen competitors. Nevertheless, steam coals are tending rather weaker for want of trade. It is said that contractors have been able to buy direct at prices below 13s. 6d. quoted for best Blyth steams, to "marry" with higher-priced coal now due to be taken out. A cargo of bunker coal is reported sold from Rotterdam to London, which suggests a new form of competition, but it may be a special consignment and of no real significance. Owing to the continued depression in the steam coal section, Clara Vale Pit, owned by the Stella Coal Company, is to work one shift instead of two, and in consequence of this 600 men and boys have received fourteen days' notice. The Durham gas coal trade position is on the whole steady, but production could easily be enlarged to meet any brisk development in demand. Best qualities are quoted at 15s. 6d. to 16s., and seconds at 13s. 6d. to 14s. With the exception of blast-furnace sorts, all kinds of coke are in strong demand. Gas makes are well booked into October, and are firmly quoted at 20s. 6d. to 21s., and then mostly in second hands, as producers have so little to offer. Beehive coke is a limited commodity, and is being actively disposed of for export at from 25s. to 30s. The ordinary brands of patent foundry coke are steady at 17s. 6d. to 18s., and the superior grades are finding a ready market at 24s. to 26s. Blast-furnace coke is not being eagerly bought at 18s., as users are hoping for lower prices, which makers say are economically out of the question.

SCOTLAND.

(From our own Correspondent.)

No Change.

So far as the steel, iron and coal trades are concerned, the past week has brought no improvement in business, and the outlook is dull. Keen competition is experienced on all hands, and it is only with difficulty that many works are kept going. Steel makers profess to be encouraged by the reception of the rebate scheme, but no extra business has apparently been the outcome so far. All branches of the steel, iron and coal trades are in need of fresh orders in order to obviate a further restriction of output, but until markets assume a greater measure of stability the chances of improvement are small.

Steel.

In several branches of the steel trade price-cutting has been resorted to in order to stimulate the demand. The recent "cut" in boiler plates has not been effective so far, while material subject to the rebate system is no busier. Practically all makers of heavy steel lack fresh specifications, and few mills are running with regularity. Sections also are disappointing.

Steel Sheets.

The lighter gauges of steel sheets, although not perhaps so busy as anticipated, are comparatively well bought, and some producers are fully booked for some months ahead. Makers of the heavier gauges are very slack, however, and inquiries are not very encouraging. Prices are comparatively firm.

Iron.

Quietness reigns in the iron trade, all branches being affected alike. The malleable works are poorly engaged, and the re-rolled steel department is similarly situated. Re-rolled steel bars have been reduced by 2s. 6d. per ton, the home quotation being £7 15s. and the export £7 7s. 6d. per ton.

Pig Iron.

Only some thirty-two pig iron furnaces are now in blast, but the output is still more than sufficient to meet all demands, and stocks continue to accumulate, despite reductions in price.

Advance in Ferro-manganese.

Ferro-manganese has again been raised in price by 10s. per ton, the current quotation being now £13 per ton for 78 per cent., delivered locally.

Imports and Exports.

Imports of iron ore last week amounted to 6200 tons, while arrivals of manufactured iron only totalled 500 tons. About 1500 tons of pig iron arrived from Calcutta. Over 4000 tons of manufactured iron were dispatched to Australia, Bombay, India, South Africa, Canada, and the United States. Tubes also figured largely in the consignments abroad.

Coal.

General market conditions are without improvement and the export department in particular is most disappointing. Outputs have increased in some districts, and many collieries have been pressing sales, with a consequent fall in prices. Many are disposed to meet buyers in the matter of price for immediate accommodation, but are not disposed to shade prices for forward delivery. Consequently, in the face of keen competition, export business is becoming increasingly difficult to secure. Aggregate shipments amounted to 252,559 tons, against 244,432 tons in the preceding week and 231,582 tons in the same week in 1925. Home demands for industrial and municipal consumption continue on restricted lines and household fuel alone shows any improvement in turnover.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Conditions.

THE state of trade so far as the steam coal industry is concerned, is undoubtedly very bad. However depressed the conditions have been in years gone by, the experience has been that some improvement has been seen towards the end of September, and in some cases buyers have even commenced to sound colliery companies as to their ideas regarding prices for supplies over the following twelve months. It is unlikely that much, if any, business will be done in this direction for export, though so far as home requirements are concerned, the Newport electricity works are in the market for 12,000 tons of small coal for delivery over six months or for 24,000 tons to be supplied over twelve months. The foreign inquiry is singularly dull, and is not as good as was the case even a month ago. That the conditions of trade are extremely unsatisfactory is shown by the state of the docks, which at the end of last week had forty-four idle loading appliances. The situation early this week had not improved to any appreciable extent as, allowing for arrivals of tonnage over the week-end, there were thirty-seven vacant berths at the various docks on Monday last. It is very clear from this that there can be no hope of any early improvement in employment, either at the docks or at the collieries, when tonnage is so inadequate. Unfortunately, this prospect is supported by returns respecting the chartering of tonnage recently. For the week ended the 23rd inst., the volume of chartering reported came to only just over 240,000 tons, which is the lowest total for a month. Exports of coal last week were also unfavourable, as the aggregate was only just over 438,000 tons, this being a decrease of rather more than 85,000 tons, as compared with the previous week.

Local Rates and Industry.

The burden of local rates is a very grave problem in this district, and on all hands ratepayers and traders in particular are complaining strongly. Representatives on municipal bodies occasionally talk about retrenchment and the suspension of any further capital expenditure, but still new schemes are entered upon. Last week there was at Cardiff a conference of local authorities when the position was fully discussed. The Government was largely blamed for the extremely heavy liabilities of local bodies, and there is some truth in this, but the Government is far from being wholly to blame. Some interesting information was laid before the conference as to the substantial advances which have taken place in the poor and Corporation rates in recent years. A notable instance is that of the Merthyr area, where the combined rate to-day is 30s. 7d. in the pound, as compared with 10s. 3d. in 1915. In other districts the increase in the rates as compared with pre-war days marked an increase of from 100 to 150 per cent. As the result of the facts put before it, the conference agreed to appeal to the Government for relief, and a committee of a representative character was elected to prepare the case for submission. Excessively high rates fall heavily in South Wales upon colliery undertakings and handicap them in their efforts to compete for foreign business. According to one estimate, for the three months ended April last local rates in the South Wales coalfield represented about 3 per cent. of the total cost of production.

Steel and Tin-plate Trades.

There is no improvement to be recorded this week in the steel and tin-plate industries of this district, although it is reported that Guest, Keen and Nettlefolds, Ltd., are engaged at their Dowlais works on the execution of an order for about 24,000 tons of rails for the Egyptian State Railways. In the tin-plate trade, it is announced that the Briton Ferry Steel Company has received a large Asiatic tin-plate order, and that the Midland Tin-plate Works of the company at Morriston will resume work on Monday next, the order being sufficient to ensure regular work for some months. The industry as a whole, however, is in a very depressed state. So far no announcement has been made respecting the ballot of the tin-plate workmen, who were asked to vote on the proposal for temporarily reducing the working hours from eight to six, so as to enable a greater number of men to take part in the work available. Ballot papers were distributed a fortnight ago to 27,000 tin-plate workers, and it is understood that a large percentage of the men are against the proposed restriction in hours. The mills at all the tin-plate works at Swansea are idle this week, consequent upon the shortage of orders. The works affected are the Cwmfelin, Baldwin's (King's Dock), Amman, Mardy, Hendy and Cambrian, the last four being under the control of the Grovesend group. This is the first time since 1921 that the mills at all the works in Swansea have been idle together for such a period.

Ship-repairing Work.

For a long time past negotiations have been proceeding between employers and representatives of labour respecting a revision of working conditions in the ship-repairing industry, so as to enable employers to compete more successfully for orders. As regards the alterations of the rules, it is understood that a ballot of the members of the Amalgamated Engineers' Society has been taken, but that a large majority of the men are against the proposed revision. The men were advised by their leaders to accept it. The *impasse* which therefore has arisen is very disappointing, especially as other sections had practically arrived at agreement.

Current Business.

Operations in steam coals are on a very restricted scale. Not only is the inquiry for forward supplies on a very meagre basis, but the demand for prompt delivery is extremely slow, and coalowners are hampered all the time by the excessive quantities of coals in stock. Large coals of all qualities are freely offered, though there has been no material decline in prices, as most owners prefer temporarily to suspend work at the pits rather than cut their quotations. Smalls and washed coals of all descriptions are steady, but patent fuel meets with a very moderate inquiry.

LAUNCHES AND TRIAL TRIPS.

LUMINETTA, oil tank steamer; built by Palmer's Shipbuilding and Iron Company, Ltd., to the order of the Astrakhan Steamship Company, Ltd.; 9000 tons deadweight. Engines, triple-expansion; constructed by the builders; trial trip, September 9th.

SAMALA, single-screw steamer; built by Cammell Laird and Co., Ltd., to the order of Elders and Fyffes, Ltd.; dimensions, 400ft. by 51ft. by 32ft. 11in. Engines, triple-expansion, reciprocating, 27½in., 46½in., 78in. diameter by 54in. stroke, pressure 210 lb.; constructed by the builders; launch, September 10th.

EDDYSTONE, screw steamer; built by D. and W. Henderson and Co., Ltd., to the order of the Clyde Shipping Company, Ltd.; dimensions, 270ft. by 37ft. by 18ft. 6in.; 1570 gross tonnage. Engines, triple-expansion, 21in., 34in., 56in. diameter with 39in. stroke, pressure 185 lb.; constructed by the builders; trial trip, September 15th.

KING EDGAR, cargo motor vessel; built by Harland and Wolff, Ltd., to the order of the King Line, Ltd.; dimensions, 400ft. by 54ft. 6in. by 34ft. 8in.; 5130 gross tonnage. Engines, six-cylinder, four-cycle, single-acting motors; constructed by the builders; launch, September 15th.

PAULA, twin-screw motor vessel; built by Harland and Wolff, Ltd., to the order of the Anglo-Saxon Petroleum Company, Ltd.; dimensions, 305ft. by 50ft. by 15ft.; 2700 gross tonnage. Engines two sets of single-acting four-stroke cycle, six-cylinder motors; constructed by the builders; launch, September 22nd.

ORANJESTAD, shallow draft oil tanker; built by Harland and Wolff, Ltd., to the order of the Lago Shipping Company, Ltd.; dimensions, 315ft. by 50ft.; to carry 2360 gross tonnage. Engines, twin-screw triple expansion; pressure, 180 lb.; constructed by the builders; trial trip, September 23rd.

GLOCLIFFE, screw steamer; built by Craig, Taylor and Co., Ltd., to the order of the Globe Shipping Company, Ltd.; dimensions, 414ft. by 53ft. 6in. by 35ft. 6in. Engines, 25½in., 42in., 70in. diameter, with 48in. stroke; pressure, 180 lb.; constructed by Blair and Co., Ltd.; launch, September 26th.

CATALOGUES.

PETTERS LTD., Westland Works, Yeovil.—Particulars of Petter oil engine driven lighting sets.

J. AND F. HOWARD, Ltd., Bedford.—Loose leaf folder of road graders and other road-making equipment.

MACMILLAN AND CO., Ltd., St. Martin's-street, London, W.C.2.—List of new and forthcoming publications.

MIDLAND ELECTRIC MANUFACTURING COMPANY, Ltd., Birmingham.—Catalogue 163 of ironclad switch and fuse gear.

BUDENBERG GAUGE COMPANY, Ltd., Broadheath, near Manchester.—Section I. of catalogue on recording pressure gauges.

BROWN, BAYLEY'S STEEL WORKS, Ltd., Leeds-road, Sheffield.—Sectionalised catalogue giving full particulars of the firm's products.

"PARMOTOR" RELAY COMPANY, 11, Blackfriars-street, Manchester.—Leaflet describing the "Parmotor" electro-magnetic relay.

HANS RENOLD, Ltd., Didsbury, Manchester.—Pamphlet illustrating many types of industrial power transmission by means of chains.

THE VISCO ENGINEERING COMPANY, Ltd., 162, Grosvenor-road, London, S.W. 1. Publication No. 274. Particulars of the "Visco" air filter.

WELLINGTON TUBE WORKS, Ltd., Great Bridge, Tipton, Staffs.—List No. 27, giving details of the types and sizes of tubes kept in stock.

THE BRITISH ALUMINIUM COMPANY, Ltd., Adelaide House, King William-street, London, E.C. 4.—Data regarding aluminium sheet, strip and circular sheets.

REAVELL AND CO., Ltd., Ranelagh Works, Ipswich.—Leaflet No. 152, illustrating the firm's electrically driven portable air compressors for use in mines.

DAVID BRIDGE AND CO., Ltd., Castleton, Manchester.—Catalogue Section C G 30, dealing with Heywood and Bridge's patent friction clutches and millgearing.

ELLIOTT BROTHERS, Ltd., Century Works, Lewisham, S.E. 13.—Section "C" of catalogue giving particulars and prices of various polyphase alternating-current instruments.

THE ROTARY AIR COMPRESSOR COMPANY, Ltd., 12, Victoria-street, London, W.C. 2.—Leaflet describing rotary air compressors for all purposes and for pressures up to 150 lb. per square inch.

THE TUNGSTONE ACCUMULATOR COMPANY, Ltd., 3, St. Bride's House, Salisbury-square, London, E.C. 4.—Catalogue giving prices and particulars of the various types of "Tungstone" accumulators.

PARSONS OIL ENGINE COMPANY, Ltd., Town Quay Works, Southampton.—Publication No. 91, which gives illustrated specifications of Parsons' stationary oil and petrol engines; also publication No. 90, of marine oil and petrol engines.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	18/6 to 21/-
(1) Spanish	18/6 to 21/-
(1) N. African	18/6 to 21/-
N.E. COAST—	
Native	18/- to 21/-
Foreign (c.i.f.)	21/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	3 16 0	—
No. 1 Foundry	3 19 0	—
No. 3 Foundry	3 14 0	—
N.E. COAST—		
Hematite Mixed Nos.	3 15 0	3 15 0
No. 1	3 15 6	3 15 6
Cleveland—		
No. 1	3 10 0	3 7 6
Silicious Iron	3 10 0	3 7 6
No. 3 G.M.B.	3 7 6	3 5 0
No. 4 Foundry	3 6 6	3 4 6
No. 4 Forge	3 6 0	3 3 6
Mottled	3 5 6	3 3 0
White	3 5 0	3 3 0
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	—	—
North Staffs. Forge	—	—
" " Foundry	3 5 0 to 3 6 0	
(3) Northampton—		
Foundry No. 3	3 1 0	—
Forge	2 17 0	—
(3) Derbyshire—		
No. 3 Foundry	3 5 0	—
Forge	3 2 6	—
(3) Lincolnshire—		
No. 3 Foundry	3 5 0	—
No. 4 Forge	3 2 6	—
Basic	3 2 6	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 7 6 (a) / 4 10 6 (b) / 4 14 0 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	10 15 0	10 10 0
Best	—	
N.E. COAST—		
Iron Rivets	11 15 0	—
Common Bars	10 15 0	—
Best Bars	11 5 0	—
LANCS.—		
Crown Bars	10 0 0	—
Second Quality Bars	9 10 0	—
Hoops	12 10 0	—
S. YORKS.—		
Crown Bars	11 0 0	—
Best Bars	12 5 0	—
Hoops	12 10 0	—
MIDLANDS—		
Crown Bars	9 10 0 to 10 0 0	
Marked Bars (Staffs.)	13 10 0	—
Nut and Bolt Bars	9 0 0 to 9 5 0	
Gas Tube Strip	11 17 6	—

STEEL. (d)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	10 10 0	10 10 0
Ship Plates, ½in. and up	8 2 6	7 12 6
Sections	7 12 6	7 2 6
Steel Sheets, ¼in.	9 0 0	8 15 0
Sheets (Gal. Cor. 24 B.G.)	14 5 0	£14 0 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 2 6	—
Angles	7 12 6	—
Boiler Plates	12 10 0	—
Joists	7 12 6	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	8 12 6	—
Soft Billets	7 12 6	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 5 0	—
Light Rails	8 10 0 to 8 15 0	
Billets	7 10 0 to 10 0 0	
MANCHESTER—		
Bars (Round)	8 10 0	—
" (Small Round)	7 15 0	—
Hoops (Baling)	10 5 0	10 0 0
" (Soft Steel)	9 0 0	8 15 0
Plates	8 7 6	—
" (Lancs. Boiler)	11 0 0	—
SHEFFIELD—		
Siemens Acid Billets	10 0 0	—
Hard Basic	7 12 6 to 8 2 6	
Intermediate Basic	7 10 0	—
Soft Basic	7 5 0	—
Hoops	10 0 0 to 10 10 0	
Soft Wire Rods	9 5 0	—
MIDLANDS—		
Small Rolled Bars	7 15 0 to 8 0 0	
Billets and Sheet Bars	6 10 0	—
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	13 17 6 to 14 0 0	
Angles	7 12 6	—
Joists	7 12 6	—
Tees	8 12 6	—
Bridge and Tank Plates	8 7 6	—
Boiler Plates	11 0 0 to 11 10 0	

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	18/- to 18/4½
Block Tin cash	266 0 0
" (three months)	264 0 0
Copper (cash)	53 17 6
" (three months)	54 3 9
Spanish Lead (cash)	20 16 3
" (three months)	21 7 6
Spelter (cash)	27 7 6
" (three months)	27 3 9
MANCHESTER—	
Copper, Best Selected Ingots	61 10 0
" Electrolytic	62 5 0
" Strong Sheets	86 0 0
" Tubes (Basis Price) lb.	0 1 0½
Brass Tubes (Basis Price), lb.	0 0 11½
" Condenser, lb.	0 1 1½
Lead, English	22 5 0
" Foreign	21 5 0
Spelter	27 7 6
Aluminium (per ton)	£107

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/8½ per lb.	
Ferro Tungsten	1/3 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	7/6
" " 6 p.c. to 8 p.c. "	£22 17 6	7/3
" " 8 p.c. to 10 p.c. "	£22 10 0	6/6
" " Specially Refined		
" Max. 2 p.c. carbon	£36 0 0	11/6
" " " 1 p.c. "	£41 10 0	15/-
" " " 0·70 p.c. carbon	£53 0 0	17/6
" " " carbon free	1/4½ per lb.	
Metallic Chromium	3/- per lb.	
Ferro Manganese (per ton)	£12 0 0 for home, £16 for export	
" Silicon, 45 p.c. to 50 p.c.	£12 15 0 scale 5/- per unit	
" " 75 p.c.	£20 5 0 scale 6/- per unit	
" Vanadium	14/3 per lb.	
" Molybdenum	5/- per lb.	
" Titanium (carbon free)	0/11½ per lb.	
Nickel (per ton)	£170	
Ferro-Cobalt	9/3 per lb.	

FUELS.

SCOTLAND.

(Prices not stable.)

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	12/9
" " Ell	13/3 to 13/6
" " Splint	14/9 to 16/-
" " Trebles	13/9 to 14/-
" " Doubles	13/- to 13/3
" " Singles	12/-
AYRSHIRE—	
(f.o.b. Ports)—Steam	13/-
" " Jewel	15/6
" " Trebles	14/6
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	11/6 to 12/9
Screened Navigation	18/-
Trebles	15/- to 16/6
Doubles	13/3
Singles	12/6
LOTHIANS—	
(f.o.b. Leith)—Best Steam	12/6 to 12/9
Secondary Steam	12/-
Trebles	14/- to 15/-
Doubles	13/3
Singles	12/3

ENGLAND.

(8) N.W. COAST—	
Steams	24/- to 25/-
Household	40/- to 56/-
Coke	22/6 to 23/-
NORTHUMBERLAND—	
Best Steams	13/6 to 14/-
Second Steams	13/-
Steam Smalls	10/6
Unscreened	13/- to 13/6
Household	21/- to 27/-
DURHAM—	
Best Gas	16/-
Second	13/9 to 14/-
Household	21/- to 27/-
Foundry Coke	19/- to 26/-

SHEFFIELD—	Inland.
Best Hand-picked Branch	27/6 to 28/6 —
Best Selected House Coal	21/- to 22/6 —
Screened House Coal	18/6 to 19/- —
" " Nuts	14/6 to 16/6 —
Yorkshire Hards	14/6 to 16/6 —
Derbyshire Hards	15/- to 17/- —
Rough Slacks	9/- to 10/- —
Nutty Slacks	7/- to 8/- —
Smalls	3/- to 5/6 —
Blast-furnace Coke (Inland)	14/- to 14/6 at ovens —
" " (Export) f.o.b.	18/6 to 19/-

(9) SOUTH WALES.

CARDIFF—

Steam Coals:	
Best Smokeless Large	20/- to 20/6
Second Smokeless Large	19/- to 19/6
Best Dry Large	18/6 to 19/-
Ordinary Dry Large	18/- to 18/6
Best Black Vein Large	18/3 to 18/6
Western Valley Large	18/- to 18/3
Best Eastern Valley Large	17/6 to 18/-
Ordinary Eastern Valley Large	17/- to 17/6
Best Steam Smalls	14/- to 14/6
Ordinary Smalls	12/- to 13/6
Washed Nuts	18/- to 21/6
No. 3 Rhondda Large	19/6 to 20/-
" " Smalls	16/- to 16/6
No. 2 " Large	17/- to 17/6
" " Through	15/6 to 16/-
" " Smalls	13/- to 14/-
Foundry Coke (export)	35/- to 40/-
Furnace Coke (export)	27/6 to 30/-
Patent Fuel	23/6 to 24/6
Pitwood (ex ship)	33/- to 33/6
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	34/- to 36/-
Seconds	28/- to 32/6
Red Vein	25/- to 30/-
Machine-made Cobbles	42/6 to 45/-
Nuts	42/6 to 47/-
Beans	27/6 to 30/6
Peas	18/6 to 20/6
Breaker Duff	8/- to 9/-
Rubbly Culm	9/6 to 10/-
Steam Coals:	
Large	18/6 to 19/6
Seconds	17/6 to 18/-
Smalls	10/6 to 12/-
Cargo Through	15/6 to 16/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (a) Delivered Glasgow. (b) Delivered Sheffield. (c) Delivered Birmingham. (d) Rebate 7/6 joists and 5/- all other materials if home consumers confine purchases solely to British products.

French Engineering Notes.

(From our Correspondent in Paris.)

The French Tariff.

THE refusal of the United States Government to admit the right of France to differentiate against American manufacturers in the matter of import duties has naturally caused some surprise in this country, since it aims at the suppression of a policy which the French Government inaugurated soon afer the Armistice of replacing the old treaties of commerce by partial treaties, whereby each country would be accorded advantages in return for concessions made in favour of French commerce and industry. As a means of bargaining the new French tariff provides a maximum scale which is four times that of the minimum, so that countries which do not accord reciprocity are practically excluded from the French market. This is the case with the United States, which had no treaty of commerce, and therefore came under the old maximum tariff, which, however, was not high enough to offer any serious obstacle to trade. Now that the maximum scale has been doubled it becomes absolutely prohibitive. At the same time, the new treaty of commerce with Germany gives to that country the most favoured nation treatment, and German manufacturers are now able to export to France the classes of goods which American firms are precluded from supplying. As a special favour the French Government offered to lessen this disability by a reduction of the import duties on American goods, but this concession was rejected by the United States, which raised what is, in effect, a question of principle that no country has the right to differentiate against another. In a word, the United States claims the most favoured treatment without being able to offer anything in return, and threatens that, unless such treatment is accorded, the import duties will be raised against French goods entering the United States. The French are unable to understand the position taken up by the United States, which has long adopted fiscal methods under which it is very difficult to do business with that country at all. The French Government is anxious to enter into a treaty of commerce with the United States, but when it is required to accord the most favoured nation treatment beforehand, there is nothing left with which to bargain for concessions, and the maximum scale becomes entirely inoperative. The French are puzzled at finding themselves in this dilemma, and unless some way can be found out of the difficulty they foresee a disastrous commercial war.

The Trade Remedy.

The French fiscal policy is ingeniously contrived to provide adequate protection for home industries, and to secure concessions from other countries which will allow of these industries producing for export. It is now seen that such a policy is not always easy of application. The United States has one tariff which does not allow of any concessions being made in return for the most favoured nation treatment from other countries, and therefore if the increased maximum scale is applied to American goods the United States Government implies that it will have no alternative but to utilise the power it possesses of putting up the import duties on French goods by 50 per cent. That would mean a complete cessation of business between the two countries. Experience shows that France must develop her export trade, which can only be done by providing facilities for a normal interchange of goods. At present the manufacturing industries are passing more or less through a period of stagnation because there is a very restricted home demand and a growing competition in foreign markets. Some blast-furnaces have been damped down, and at a meeting in Paris of the French, Belgian and Luxemburg foundry iron producers the question of allotting quantities for export was discussed. A final decision was, however, deferred, and it was decided to make no change in prices, although producers were left at liberty to quote down, if necessary, to meet English competition. In the steel trade the situation has not been improved by the operations of the Steel Cartel, which has failed in its object of maintaining prices, but it has at least given to the steel industry some sort of organisation that prevents it from lapsing into chaos. In the engineering industries there is very little business beyond a few colonial orders, although some firms are fairly well employed, notably the Compagnie des Batignolles, which is engaged upon the construction of the railway between Brazzaville and Pointe-Noire in French Equatorial Africa. The colonial government has entered into a new agreement with the Compagnie des Batignolles whereby it will supply the necessary means of mechanical transport to permit of the number of native porters being reduced by one half. Much of the work being effected at home and in the Colonies is carried out partly with German material supplied on account of reparations, but this fact would not affect the situation of the engineering trades to any great extent if confidence in the situation generally could be restored and encouragement could be given to private enterprise.

Shipbuilding.

Shipbuilders have been complaining for a long while past that there can be no activity in private yards unless financial assistance is provided by the State. Very little is being done for the merchant marine because owners are unable to give out orders, and it is doubtful, indeed, whether they want to do so in view of the poor freights and the number of ships that have been laid up in the ports because there is no profit to be made. At the same time the activity of the Italians and the Spaniards has shown the French that something must be done to strengthen the merchant fleet and to build larger vessels with more economical propelling machinery, and as a means of enabling this course to be taken the Government is preparing a Bill whereby the companies, which do not receive State subsidies, will be provided financial aid in the form of credits for the building of ships up to 75 per cent. of the cost. It is proposed to advance 1000 million francs during a period of five years at a low rate of interest. The facilities that were accorded to shipbuilders some time ago for procuring certain materials and machines from abroad without payment of import duty, when the ships are built to foreign orders, aroused so much protest from home manufacturers that they have had to be withdrawn.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

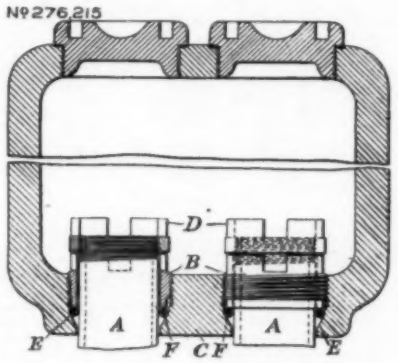
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

276,215. December 28th, 1926.—SUPERHEATER TUBE JOINTS, Galloways, Ltd., Knott Mill Ironworks, and H. Pilling, Glenderwyn, Manchester-road, Chorlton, Manchester.

The tubes A are inserted in the ferrules or glands B, each of the latter having a plain bore, but a threaded exterior, enabling them to be screwed into the correspondingly threaded portions of the sockets formed in the header C. The ends of the tubes A are screw-threaded to receive the castellated nuts D. The sockets in the header have a tapered or coned portion as E to

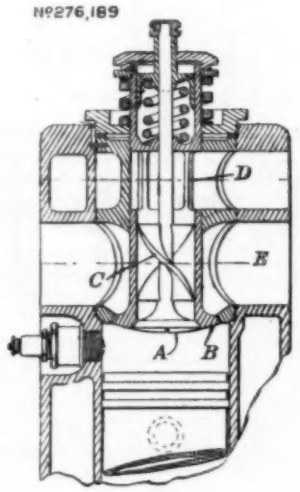


receive or form a seating for the soft metal or other jointing ring F. The outer ends of the glands are castellated. When the glands are screwed tightly home the rings F are compressed between the tapered or coned parts E and the tubes A so as to secure the tubes in place and a steam-tight union is thereby obtained between the tubes and the header. The nuts D are screwed on to the extremities of the tubes after the latter have been inserted in the header and serve as a security against any possibility of the blowing out or displacement of the tubes.—*August 25th*, 1927.

INTERNAL COMBUSTION ENGINES.

276,189. October 25th, 1926.—VALVE MECHANISM, J. E. Emyl-Jones, 4, Dock Chambers, Cardiff; and B. T. Llewellyn, 2, Parkfield-place, North-road, Cardiff.

In this engine the inlet valve A is housed within the hollow stem of the exhaust valve B, and helical baffles C are provided



to produce a vortex action in the incoming charge, which is said to help scavenging. Induction takes place through the ports D, while the exhaust is at E. The whole assembly of valves is mounted in a sleeve and can be withdrawn bodily from the cylinder head.—*August 25th*, 1927.

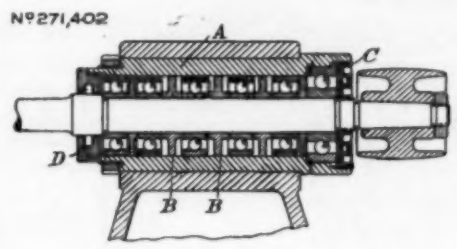
MACHINE TOOLS AND SHOP APPLIANCES.

276,242. February 22nd, 1927.—SCREWING TAPS, *L. Mellersh-Jackson*, 28, *Southampton-buildings, London, W.C. 2.*

In this specification claim is made for "A screw thread cutting tool having its apex formed at a more acute angle than the flanks of adjacent threads to be cut, said apex extending beyond the extreme diameter of said thread." The object is to provide material on the point of the tool which may wear away without the thread cut becoming so rounded that it will not pass the master gauge. The thread shown is of the American standard, and it is suggested that, while the flanks of the thread have an angle of 60 deg., those of the extension should be at 30 deg.—*August 25th*, 1927.

271,402. November 30th, 1926.—BEARINGS FOR GRINDING MACHINES, K. Jung, 48–49, Köpenickerstrasse, Berlin, Germany.

This bearing is said to be specially applicable to grinding machines and has, the inventor says, the advantage that bending

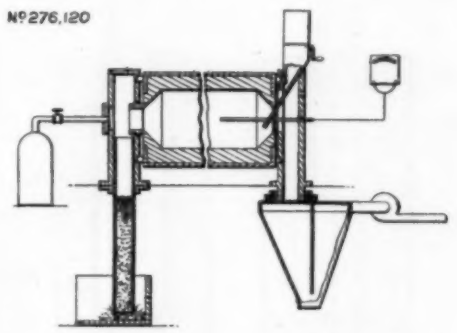


of the shaft is prevented, while the merits of the ball bearing are retained. As will be seen from the drawing, a long series of ball bearings is assembled in a sleeve A and spacers B B are arranged between the bearings. Nuts are provided at C and D to clamp the bearing rings in place.—*September 1st*, 1927.

METALLURGY.

276,120. July 20th, 1926.—THE PRODUCTION OF CHROMIUM COMPOUNDS, *L. Mellersh-Jackson*, 28, *Southampton-buildings, Chancery-lane, London, W.C. 2.*

The process of producing chromium chloride described in this specification comprises chlorinating a non-oxidised mixture or alloy of chromium and iron (ferro-chromium) at a temperature not higher than about 650 deg. Cent. and under non-oxidising

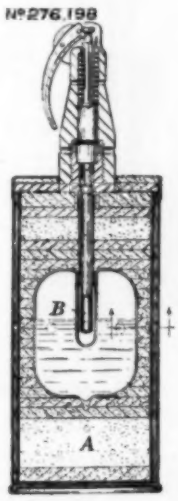


conditions, whereby iron present is removed as ferric chloride and chromium chloride is formed in the reaction chamber in soft solid form, readily pulverisable to talc-like fineness, and removing the chromium chloride under conditions preventing oxidation thereof. The illustration shows the apparatus employed.—*August 25th*, 1927.

ORDNANCE AND ARMOUR.

276,198. November 12th, 1926.—SMOKE BOMBS, H. G. Mason, Chemical Warfare Experimental Station, Porton, Salisbury.

This invention is for improvements in or relating to the production of smoke and apparatus therefor, and has for its object to provide a method and means for producing smoke without at the same time producing flames, sparks or such heat effects as would involve any fire risks. An important application of the invention lies in the production of smoke bombs for use by the pilots of aircraft; in some cases, as, for example, when landing, it is desirable that the pilot should know the direction of the



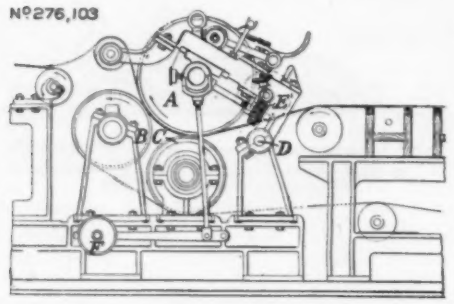
wind, and he does this by dropping a smoke bomb, and it is essential that the bomb should be of such a nature that there is no risk of it setting fire to anything, such as might happen in a dry climate if the bomb should fall on crops or grass land. The bomb comprises a tinned steel container lined with asbestos and perforated with small holes. At the bottom there is a layer of quicklime A. Above there is a glass vessel containing 60 per cent. of chlorosulphonic acid and 40 per cent. of sulphur trioxide. It is supported by a packing of felt pads. When required, the glass vessel is burst by a detonator B.—*August 25th*, 1927.

MISCELLANEOUS.

276,103. June 8th, 1926.—COUCH ROLLS OF PAPER MILLS, S. A. MacIvor, Greendale, Hawkshaw, Darwen, Lancs.

Couch rolls are, of course, used to squeeze water out of paper

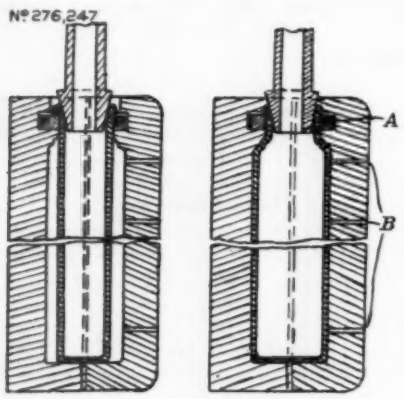
web before it leaves the wire cloth on which it is made. Instead of the usual combination of two rolls the inventor employs three, A, B, and C. The upper roll A is mounted in a frame pivoted at D and its bearings can be moved in the frame by the screw gear



E. It is weighted at F. By these means the pressure of A on B and C can be adjusted in any desired manner.—*August 25th*, 1927.

276,247. February 24th, 1927.—AN IMPROVED METAL BLOWING PROCESS, E. Asberger and L. Hinkel, Glockendonstrasse 2, Nuremberg, Germany.

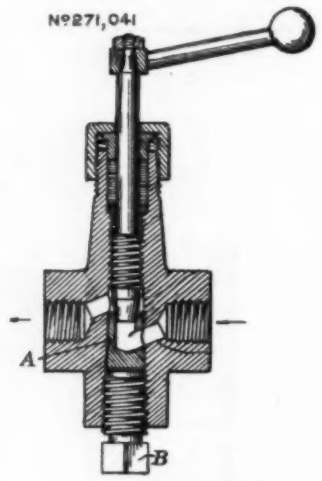
The inventors make the assertion that a metal tube is strongest when the fibres of its material form a network of close mesh, in such a way that the tube can be fairly uniformly stressed both in a radial and in an axial direction by the forces to which it is



subjected. The manufacture of such a tube is rendered possible by the present invention, according to which the tube is distended in a glowing condition by means of compressed air or other gaseous medium. The illustrations show a closed-ended tube inserted in a two-part mould in a glowing condition and the same tube after distention. A sealing ring A is employed to prevent the escape of the compressed air, while vents are provided at B B.—*August 25th*, 1927.

271,041. March 5th, 1927.—HIGH-PRESSURE VALVES, The Mathieson Alkali Works, 250, Park-avenue, New York.

This valve is intended for very high pressures, such as 5000 lb. per square inch. The object is to provide an easily renewable seating. The screw-down valve stem is made of hardened and



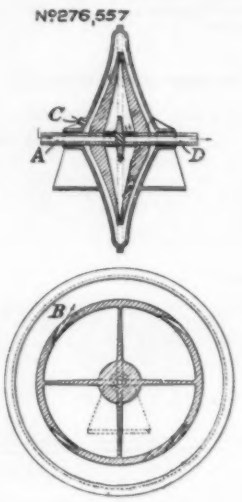
polished steel. The seating A is of a softer material, such as Monel metal. The seating is tapered and is forced into place by a set screw B. There is an anti-friction washer between the set screw and the seating, to prevent the latter being turned.—*September 1st*, 1927.

262,473. December 6th, 1926.—IMPROVEMENTS IN OR RELATING TO ELECTRICAL CONDENSERS IN MATERIALS FOR DIELECTRIC PURPOSES AND A PROCESS OF PREPARING THE MATERIAL, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C. 2.*

This specification deals with dielectric materials having high permittivity and high resistivity as compared with dielectrics, such as paper saturated with insulating oil or mica, and describes a method of purifying or conditioning this material. It has been found that materials having high permittivity may, if properly conditioned, be effectively used for dielectric purposes, and that very effective electrical condensers may be made from such materials. Among the materials having high permittivity are nitrobenzene, nitrotoluene, paraldehyde, acetophenone, titanium oxide. It has been found that in place of paper saturated, for example, with transil oil, paper saturated with some of the foregoing materials may be used. The specification contains a great deal concerning the processes involved, and it is claimed that by the use of certain materials and methods, condensers of a given size can be made for from five to six times the usual capacity.—*September 1st*, 1927.

276,557. January 15th, 1927.—CENTRIFUGAL APPARATUS, Synthetic Ammonia and Nitrates, Ltd., Billingham, Stockton-on-Tees, and H. A. Humphrey, Norton Hardwick, Stockton-on-Tees.

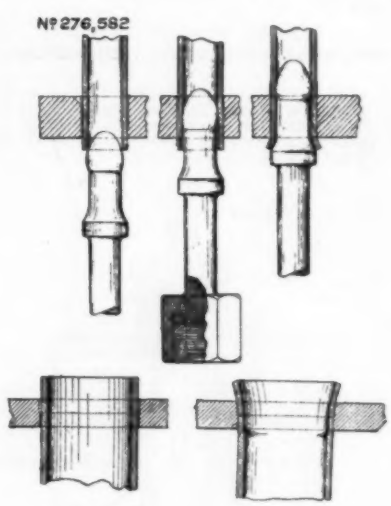
This apparatus is for the separation of mixed gases, especially in the production of carbon dioxide. It comprises two screw-shaped discs joined together at the periphery and mounted on a



hollow shaft, which is driven at such a speed that the circumference travels at 600 m. a second. The mixed gases enter at A. Those of greater density fly to the rim and escape by the nozzles B, so that they help to rotate the apparatus, and are drawn off at C. The lighter gases pass away at D. It is said that the compression of the heavier gas may be so great as to liquefy carbon dioxide if it is pre-cooled.—*September 1st*, 1927.

276,582. March 24th, 1927.—FASTENING TUBES IN TUBE PLATES, *Babcock and Wilcox, Ltd., Farringdon-street, London, E.C.*

In this specification claim is made for "The method of expanding and securing a metal tube end in a hole in a metal sheet by means of a tool provided with a peripherally continuous rounded head of a diameter greater than the internal diameter of the tube and followed by a portion flaring outwardly to a diameter greater than that of said head, said hole being surrounded by a wall provided with a groove and having a diameter greater than



the external diameter of the tube, which consists in holding the end of the tube in said hole, progressively forcing the head of the tool into the tube, thereby locally expanding the metal of the tube, as the movement of the tool progresses, and then forcing said flaring portion of the tool into the extreme end of the tube, thereby flaring it outwardly to a diameter greater than that of the hole." In the drawing the upper figures show the process in progress, while the lower views are of an unexpanded and a finished tube.—*September 1st*, 1927.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

SATURDAY, OCTOBER 1st.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—College of Technology, Sackville-street, Manchester. Presidential address by Mr. J. S. G. Primrose. Lecture, "Motor Cylinder Castings," by Mr. W. West. 4 p.m.

INSTITUTION OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOCIATION.—Visit to the Bardley Green and Frankley Reservoirs of the City of Birmingham Water Department. 10.30 a.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Council Chamber, Municipal Buildings, Guildhall-square, Plymouth. South-Western District meeting. 11 a.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—North-Eastern District meeting at Shildon, Durham. 2 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—Visit to the works of S. G. Brown, Ltd., at North Acton. 3 p.m.

MONDAY, OCTOBER 3RD.

BRADFORD ENGINEERING SOCIETY.—Technical College, Bradford. Inaugural address, "Little Things that Matter," by the President, Mr. W. S. Siddons. 7.30 p.m.

TUESDAY, OCTOBER 4TH.

INSTITUTE OF METALS: NORTH-EAST COAST LOCAL SECTION.—Electrical Engineering Lecture Theatre, Armstrong College, Newcastle-on-Tyne. Address by the Chairman, Mr. H. Dunford Smith. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Great Gallery of the Royal Automobile Club, Pall Mall, London, S.W. 1. Presidential address, "The Influence of the Automobile User upon the Automobile Engineer," by Major E. G. Beaumont. 8 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: SOUTH MIDLAND STUDENTS' SECTION.—Queen's Hotel, Birmingham. Paper, "Finance and Engineering," by Mr. G. L. E. Metz. 7.30 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—39, Elmbank-crescent, Glasgow, C. 2. Presidential address, by Mr. R. D. Moore. 7.30 p.m.

SHEFFIELD METALLURGICAL ASSOCIATION.—198, West-street, Sheffield. "Refractories in the Iron and Steel Industry," by Mr. A. J. Dale. 7.30 p.m.

WEDNESDAY, OCTOBER 5TH.

MANCHESTER METALLURGICAL SOCIETY.—The Engineers Club, Albert-square, Manchester. Presidential address, by Mr. E. L. Rhead. 7 p.m.

FRIDAY, OCTOBER 7TH.

DIESEL ENGINE USERS ASSOCIATION.—Caxton Hall, Westminster, London, S.W. 1. Paper, "Some Fuel Experiments in a Mechanical Injection Oil Engine," by Mr. E. L. Bass.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, Westminster, London, S.W. 1. Lecture, "Lubrication," by Professor Edwin Edser. 7.30 p.m.

SATURDAY, OCTOBER 8TH.

ELECTRICAL POWER ENGINEERS' ASSOCIATION: SOUTHERN DIVISION.—Hotel Cecil, Strand, London, W.C. 2. Annual dinner. 5.30 for 6 p.m.

TUESDAY, OCTOBER 11TH.

INSTITUTE OF MARINE ENGINEERS.—85–88, The Minories, Tower Hill, London, E. 1. Paper, "A New Form of Insulating Material for High Temperatures," by Mr. A. F. C. Timpson. 6.30 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

THE CHATTERIS ENGINEERING COMPANY, Ltd., has removed its London office to 17, St. Swithin's-lane, E.C. 4.

ARCHIBALD D. DAWNAY AND SONS, Ltd., Steelworks-road, Battersea, S.W. 11, have purchased the extensive structural engineering works, lately occupied by Sir William Arrol and Co. (Swansea), Ltd., at King's Dock, Swansea. It is the new owners' intention to develop the Swansea works on the most up-to-date lines and to pay special attention to the export trade. The works are in close proximity to the extensive docks at Swansea, with every facility for the transportation of material.

CONTRACTS.

AMONG recent contracts the Wellman Bibby Company, Ltd., has received repeat orders from Dorman, Long and Co., Ltd., and the Newcastle-upon-Tyne Electric Supply Company, Ltd., for its patented air filters.

BRITISH BROWN-BOVERI, Ltd., informs us that its organisation has recently received an order from Japan for two three-phase 30,000-kVA 600 r.p.m. synchronous condensers for use on an 11,000-volt, 60-period system. They will be provided with direct mounted main and auxiliary exciters and induction motors for starting purposes. The order includes in addition a stand-by exciter set and the necessary switchgear with automatic voltage and current-limiting regulation. These synchronous condensers, it is stated, will be the largest so far manufactured in Europe, and will be among the largest yet installed.

AN order for a pneumatic coal-handling plant has been received by Henry Simon, Ltd., conveying engineers, Manchester, from the Sumitome Steel Tube and Copper Works, Ltd., of Osaka, Japan. The plant will have a handling capacity of 10 tons per hour and will be used for discharging barges and delivering the coal to conveyors feeding storage dumps. The coal to be handled will be washed nuts ranging from ¼in. up to 1¼in. cube. The pneumatic equipment will be erected on a structural steel tower on the dock side, and will include a swivelling pipe boom which will obviate the necessity for moving the barges during discharge. The tower will carry the coal receiver, automatic discharging seal, dust collector, weighing machine and the conveyors feeding the dump. The necessary suction will be provided by an electrically driven "Simon" vertical vacuum pump arranged below the tower.

HOW TO GET A WELFARE SCHEME ADOPTED.—"If ever you are called upon to carry on any kind of propagandist work with employers," said Mr. Robert R. Hyde, Director of the Industrial Welfare Society, at the Incorporated Secretaries' Association Conference at Buxton, on September 24th, "I suggest that you act upon the two suggestions I make. First, study the doorkeeper and the nature of your reception. If he is surly, indifferent, slack; if you are kept hanging about in a draughty, crowded porch; if the wall displays a dirty, dog-eared notice urging you to be brief, to be business-like, to be gone—you may be pretty sure that your interview with the head of the concern is going to be unsatisfactory. The doorkeeper is invariably the counterpart of his 'boss.' Secondly, make friends with the secretary. In these days of specialisation the man behind the scenes plays an important part, for it is upon his judgment, interest and knowledge that movements are estimated. He it is who pens the courteous note stating that 'the managing director regrets his inability,' &c."